King's College
Library
JUN 23 1927

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLIII.—No. 3726] LONDON: FRIDAY EVENING, JUNE 10, 1927 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

FIRE SERVICE, &c.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 24th June, 1927, for the INSTALLATION of FIRE and DOMESTIC PUMPS and AUTOMATIC CONTROLS at the "Metropolitan" Telephone Exchange, Wood-street, E.C. Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 5640

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 23rd June, 1927, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at "Archway" Telephone Exchange, Pine-grove, N. Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 5639

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 23rd June, 1927, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at the Reliance (Oval) Telephone Exchange, White Hart-street, Kennington, S.E. Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 5682

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

1. 8000 CAST STEEL or MALLEABLE CAST IRON AXLE-BOXES.
2. 400 STEEL TYRES for COACHING STOCK.
3. 1520 PAIRS of DISC WHEELS and AXLES for COACHING STOCK.
4. 1740 STEEL AXLES for COACHING STOCK.

Tenders due on the 24th June, 1927, for No. 1, and on the 28th June, 1927, for Nos. 2 to 4.

Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 5677

Metallurgical Assistant. APPLICATIONS are INVITED for a POST of METALLURGICAL ASSISTANT, Grade II., in the Ordnance Factories. Scale of pay 22s., 2s. annually, 42s. per week plus Civil Service bonus (which varies with cost of living), giving at present a range of remuneration of 57s. 7d. to 72s. 7d. per week. Candidates must be British subjects over 21 years of age and have had a metallurgical or chemical training. There are higher posts to which they are eligible for promotion by merit as and when vacancies occur, but for which the possession of an Honours Degree in Chemistry or of an equivalent Diploma is essential. Preference will be given to ex-Service men.

Forms of application, which must be returned not later than 24th June, may be obtained from CHIEF SUPERINTENDENT of ORDNANCE FACTORIES, Royal Arsenal, Woolwich, S.E. 18. 5637

Storekeeper Required for the GOVERNMENT RAILWAY of the FEDERATED MALAY STATES for four years' service, with prospect of permanency. Salary, dollars 325 a month, rising by dollars 25 a month to dollars 375 a month, plus a strictly temporary non-pensionable cost-of-living allowance of 10 per cent. of salary for bachelors and dollars 80 a month for married men. Officers of exceptional merit may eventually rise to a maximum salary of dollars 500 a month. A bonus of six months' salary is payable if employment ceases on the termination of the four years' service, provided that the officer's work and conduct have been entirely satisfactory. The Government rate of exchange is now 2s. 4d. to the dollar, but the purchasing power of the dollar in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free second-class passages, and, subject to certain conditions, for wife and children (also, not exceeding four persons beside the candidate selected. Candidates, aged 23 to 35, must have a practical knowledge of General Stores commonly in use on Railways, practical experience of Stock Keeping in Stores Warehouse, preferably Railway, together with such knowledge of Accounts and Correspondence as is necessary for same.—Apply at once by letter, stating whether married or single, age and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/15,216. 5692

The Government of the PUNJAB REQUIRE the SERVICES of an ENGINEER for the Electrical Department, Buildings and Roads Branch.

Candidates should have been regularly engaged in the practice of Electrical Engineering, should possess a recognised degree in engineering and have obtained the Corporate Membership of the Institution of Electrical Engineers. Should preferably have practical experience of the design and erection of electrical supply undertakings. Age 30 to 36 years.

Agreement for five years in the first instance. Pay in accordance with an age scale (e.g., age 30, Rs. 725 a month plus overseas pay £25 a month; age 36, Rs. 1025 a month plus overseas pay £30 a month). Provident Fund with Government bonus of 100 per cent. of subscription. Free first-class passage to India and return on satisfactory termination of agreement. Return passage and overseas pay admissible only to an officer of non-Asiatic domicile.

Forms of application and further particulars may be obtained (upon request by postcard) from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 25th June, 1927. 5645

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

The Stourport Electric Generating Station.
THE ENGINEER, 10-6-27.

High Steam Pressure and Temperature in an American Power Station.
(ALEX. D. BAILEY.) THE ENGINEER, 10-6-27.

Tests of a New 2-8-4 Locomotive.
(E. C. POULTNEY.) THE ENGINEER, 10-6-27.

Incorporated Municipal Electrical Association at Buxton—No. II.
THE ENGINEER, 10-6-27.

A New Process of Combustion for Heavy-Oil Engines.
THE ENGINEER, 10-6-27.

A New Wireless Receiver.
THE ENGINEER, 10-6-27.

A Large Boring Machine for Turbine Cylinders. THE ENGINEER, 10-6-27.

80 H.P. Turbine Fire Engine.
THE ENGINEER, 10-6-27.

PUBLIC NOTICES

Administrative County of LONDON.
ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY.

The London County Council invites APPLICATIONS for the AWARD of TWO ROBERT BLAIR FELLOWSHIPS in APPLIED SCIENCE and TECHNOLOGY, each of the value of £450, tenable for one year. The Fellowships are for advanced study or research in applied science and technology, and will be tenable in the Dominions, the United States or other foreign countries.

Candidates must be British subjects and at least twenty-one years of age.

Further particulars and applications forms (T.2.a/309) may be obtained from the Education Officer (T.2.a.), The County Hall, S.E. 1 (stamped addressed envelope necessary), to whom the form must be returned by 18th June, 1927.

MONTAGU H. COX,
5425 Clerk of the London County Council.

Battersea Polytechnic. LONDON, S.W. 11.

The Governing Body invite APPLICATIONS for the POSITION of PRINCIPAL of the POLYTECHNIC, owing to the resignation of Dr. R. H. Pickard, F.R.S., upon appointment as Director of the British Cotton Industry Research Association.

Salary, £1250-£50-£1500.

Applications to be made not later than June 13th.

Full particulars obtainable on application to the CLERK TO THE GOVERNING BODY. 5516

University College of Swansea. The Council of the College invites APPLICATIONS for the POST of ASSISTANT PROFESSOR of METALLURGY. Salary £750 per annum. The appointment will date from the 1st September, 1927.

Further particulars may be obtained from the undersigned, by whom applications must be received on or before the 2nd July, 1927.

EDWIN DREW,
Registrar.
Singleton Park, Swansea. 5452

PUBLIC NOTICES

Borough of Watford. SALE OF WATERWORKS MACHINERY.

The Corporation invites TENDERS for the PURCHASE and REMOVAL of the following MACHINERY and PLANT now situated at the old Waterworks, Local Board-road, Watford :—

LOT NO. 1.

One 40 H.P. Compound Jet Condensing Beam Engine driving 6 Lift Pumps delivering 972 gallons per minute. Manufactured by George Tridcombe and Son, 1878.

And One disused Treadle Lathe with 7in. bed and 71in. centre.

LOT NO. 2.

One 75 H.P. Compound Jet Condensing Beam Engine driving One Bucket and Plunger Pump delivering 1200 gallons per minute against 170ft. head. Designed by E. Easton and Co., Ltd., and manufactured by Messrs. Grimson and Co., 1885 (suitable for re-use).

And One Riveted Steel Air Vessel, 4ft. 6in. by 15ft.

Particulars and orders to view may be obtained on application to Mr. W. W. Newman, A.M.I.C.E., F.S.I., Borough Engineer, Municipal Offices, 14, High-street, Watford.

Tenders, in sealed envelopes, endorsed "Tender for Purchase of Machinery," are to be delivered to the undersigned not later than 9 a.m. on Monday, 18th July, 1927.

The Corporation reserves the right to sell the lots separately and does not bind itself to accept the highest or any Tender.

W. HUDSON,
Town Clerk.
Municipal Offices,
14, High-street, Watford. 5648

The Assam-Bengal Railway COMPANY, Ltd., is prepared to receive TENDERS for—

30 CARRIAGE UNDERFRAMES and BOGIES.

Specifications and Tender forms may be obtained at the offices of the Company, Bishopsgate House, 80, Bishopsgate, E.C. 2. A fee of £1 1s. is charged, which cannot, under any circumstances, be returned.

Drawings may be had, at the cost of the tenderer, by application to Messrs. Hodges Bennett and Co., Ltd., 78, Queen Victoria-street, E.C. 4.

Tenders must be delivered at the Company's Offices not later than Noon on Thursday, the 30th June, 1927.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
G. HUDDLESTON,
Managing Director.
8th June, 1927. 5681

PUBLIC NOTICES

KLINGER v. KRAMMER.

In the High Court of Justice
Chancery Division
Mr. Justice Russell.

On the 6th day of May 1927 in an action brought by RICHARD KLINGER LIMITED of 120, Southwark street, London, S.E., Mr. RICHARD KLINGER of Gumpoldskirchen, near Vienna, Austria (the well-known manufacturers of Klinger's Reflex Water Gauges, Klinger's Seatless Piston Valves, "Klingerit" H.P. Jointing and other products) and others against Mr. JOSEPH KRAMMER of 66, Fenchurch-street, London, E.C., trading there under the name of "Richard Klinger and Co." the defendant, the said Mr. Joseph Krammer gave an undertaking embodied in an Order of the Court forthwith (amongst other things) to discontinue trading under the name of "Richard Klinger and Co." or any name containing the work "Klinger" or under any name only colourably differing therefrom.

RICHARD KLINGER LTD.
(Signed) THEODORE WALFORD
Secretary.

Witness to the signature of
Theodore Walford
Percy C. Atkins,
10/11, Austin Friars,
London, E.C. 2,
Solicitor. 5691

City of Bath. OFFERS are INVITED for the following PLANT and LAMPS :—

Two Babcock and Wilcox Marine Type Boilers, complete with Underfeed "E" Type Stokers, Forced Draught Fan, Steel Chimneys and Dust catchers. Each boiler is capable of an evaporisation of 12,000 lb. (from and at) at a working pressure of 160 lb. The plant is in good working order and can be inspected by appointment.

10,000 110-Volt Lamps of various make and candle-power, some in new condition and others removed from consumers' premises in connection with change of voltage of supply.

Full particulars can be obtained from the undersigned.

J. W. SPARK,
5680 City Electrical Engineer.

Lewisham Union. The Guardians of the Poor of the Lewisham Union invite TENDERS for the PROVISION and ERECTION of a STEAM and ELECTRIC STERILISER PLANT for the Operating Theatre at the Lewisham Hospital, S.E.

The work is required to be executed in accordance with the drawing and specification prepared by the Guardians' Consulting Engineer, Mr. G. W. Martin, M.I. Mech. E., of 33, Arran-road, Catford, S.E.

The drawings can be seen at the Guardians' Offices, and the form of Tender and specification can be obtained from the undersigned on receipt of a deposit of £1 1s., which is returnable on receipt of a bona fide Tender.

Tenders are to be returned to me by 10 a.m. on Monday, the 4th July, 1927, in a cover to be endorsed "Tender for Steriliser Plant."

The Guardians do not bind themselves to accept the lowest or any Tender.

By Order,
W. R. OWEN,
Clerk to the Guardians.
Guardians' Offices,
394, High-street, Lewisham, S.E. 13,
3rd June, 1927. 5638

PUBLIC NOTICES (continued) Page 2.
SITUATIONS OPEN, Pages 2 and 3.
SITUATIONS WANTED, Page 3.
PARTNERSHIPS, Page 3.
AUCTIONS, Page 94.
EDUCATIONAL, Page 3.
AGENCIES, Page 3.
MACHINERY, &c., WANTED, Page 3.
FOR HIRE, Page 4.
FOR SALE, Pages 4, 8 and 94.
PATENTS, Page 4.
MISCELLANEOUS, Page 4.
BUSINESSES and PREMISES (For Sale, etc.), Page 94.
WORK WANTED, Page 8.

For Advertisement Rates see Leader Page.

INDEX TO ADVERTISEMENTS, PAGE 93.

PUBLIC NOTICES

Limerick Harbour Commissioners.

LIMERICK HARBOUR.
CONSTRUCTION OF NEW DOCK.

The Limerick Harbour Commissioners invite TENDERS for the CONSTRUCTION of a NEW DOCK at Limerick, comprising about 6¼ acres in extent, including Excavation, Dock Walls, New Entrance and Dock Gates, Entrance Jetties, Dredging and other Works, as provided for in the plans, specification and conditions of contract, which may be inspected at the office of Mr T. P. O'Sullivan, B.E., Harbour Engineer, Limerick, or the office of the Consulting Engineer, Mr. P. H. McCarthy, M.A., B.A.I., M. Inst. C.E.I., 26, Lower Lesson-street, Dublin, during the usual office hours.

Forms of Tender, conditions of contract, specification, and schedule of quantities may be obtained from the undersigned on payment of a deposit of £20, which will be returned on receipt of a bona fide Tender, together with all the aforesaid documents.

Tenders, enclosed in sealed envelopes, addressed to the undersigned and marked "Tender for New Dock," must be delivered at the offices of the Commissioners not later than Ten o'clock a.m. on 20th day of July, 1927.

The Commissioners do not bind themselves to accept the lowest or any Tender nor will the Commissioners be responsible for any expenses incurred by persons tendering.

JOHN F. POWER,
Secretary,
Limerick Harbour Commissioners.

Limerick Harbour Commissioners' Office,
Limerick. 5492

Metropolitan Water Board.

TENDERS FOR THE SUPPLY OF STORES, &c.

The Metropolitan Water Board invite TENDERS for the SUPPLY of the under-mentioned STORES, &c., for the periods of six and twelve months commencing 1st August, 1927 :—

Tender No.
2 .. BRUSHES and BROOMS.
5 .. COTTON WASTE, &c.
9 .. HEMP ROPE, YARN, &c.
10 .. LEAD BRASS, &c.
13 .. OILMAN'S SUNDRIES.
14 .. PACKINGS, BELTING, &c.
15 .. PAINTS, &c.
18 .. SCRAP IRON (DISPOSAL OF).
24 .. ELECTRIC LAMPS.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer on and after Thursday, 9th June, 1927, by personal application at the Board's offices (Room 156), or upon forwarding a stamped addressed brief envelope.

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk, Metropolitan Water Board, 173, Rosebery-avenue, E.C. 1," and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Thursday, 23rd June, 1927.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1.
4th June, 1927. 5680

Parish of Ipswich.

HEATING AND HOT WATER SUPPLY INSTALLATION FOR THE IPSWICH POOR LAW INSTITUTION.

The Guardians of the Poor of the Parish of Ipswich invite TENDERS for a complete CENTRAL HEATING and HOT WATER SUPPLY INSTALLATION, including STEAM BOILER PLANT, PUMPS, CALORIFIERS, &c., to be erected at their Infirmary, "Heathfields," in accordance with the plans and specification prepared by the Guardians' Consulting Engineer, George W. Martin, M.I. Mech. E., of 33, Arran-road, Catford, London, S.E. 6.

Plans and specification can be seen either at the Guardians' Offices or the Consulting Engineer's Office, and copies may be obtained on payment of a fee of Two Guineas, which will be returnable on receipt of a bona fide Tender which is not subsequently withdrawn. Applications for plans and specification to be received not later than Ten o'clock on Saturday, June 18th, after which date applications cannot be considered.

The contractor will be required to pay such rates of wages as are recognised by the Trades Unions concerned or are generally accepted as fair in the respective trades.

The Guardians do not bind themselves to accept the lowest or any Tender.

By the Order of the Board,
L. W. GREENHALGH,
Clerk to the Guardians.

Guardians' Offices,
19, Tower-street, Ipswich,
7th June, 1927. 5667

Borough of Bromley.

A PRACTICAL MAN is REQUIRED by the Bromley Corporation to act as FOREMAN FITTER in charge of the Refuse Destructor and Depot under the direction of the undersigned.

Applicants should be apprenticed steam fitters and preferably have had previous experience in the working of a Refuse Destructor.

Age not to exceed 40 years.

Wages £4 16s. per week.

The successful candidate will be required to pass a medical examination and to contribute to the Corporation's Superannuation Scheme.

Applications, in candidates' own handwriting, stating age, present position, previous experience, accompanied by copies of not more than three recent testimonials and endorsed "Foreman Fitter," should reach the undersigned not later than Friday, June 24th, 1927.

STANLEY HAWKINGS,
Borough Engineer.

Municipal Offices,
Bromley, Kent.
June 7th, 1927. 5671

PUBLIC NOTICE.

Bombay Municipality.

APPLICATIONS are INVITED for the POST of the DEPUTY EXECUTIVE ENGINEER, DRAINAGE, on a salary of Rs. 1200-50-1500 per mensem, plus conveyance allowance in accordance with the rules of the Corporation.

The post is at present a supernumerary one, but the selected candidate will be confirmed in the post on the 1st April, 1928, or after such period of probation not exceeding 6 months in all, as may be considered necessary.

Applicants must have been regularly trained as Civil Engineers, particularly in Sanitary Engineering, and should have had preferably about 10 years' practical experience in Civil Engineering. They must have administrative ability and good and sound knowledge and experience in designing, estimating, supervising and maintaining large Drainage and Sewerage Works. They must be Corporate Members of the Institution of Civil Engineers (England) or the Institution of Engineers (India), or must hold the Testamur of the Institution of Municipal and County Engineers, or must be Graduates in Civil Engineering of any recognised European, American, or Indian University.

Applications, stating age, training and qualifications, with copies of not more than three testimonials and two references, should be addressed to the Municipal Commissioner for the City of Bombay, and should reach him not later than 31st August, 1927.

The successful candidate will be entitled to the benefit of the Leave Rules and Provident Fund Rules applicable to Municipal Servants for the time being in force.

Employees in Bombay municipal service are not debarred from applying for the post, but such applications should be made through the heads of their respective Departments.

H. B. CLAYTON,
Municipal Commissioner for the City of Bombay.
Municipal Offices, Bombay,
20th May, 1927. 5683

PUBLIC NOTICES

The Madras and Southern Mahratta Railway Company, Ltd.,

25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for—

236 Tons STRUCTURAL STEELWORK for ENGINE SHED (together with Corrugated Asbestos Sheets, Glazing Bars, Wire-woven Glass, &c. &c.).

Tenders are due in on Friday, 1st July, 1927, by 10.30 a.m. Tender form obtainable at above address. Fee ONE GUINEA, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 5679

Punjab Public Works Department.

HYDRO-ELECTRIC BRANCH.

APPLICATIONS are INVITED from candidates to fill an APPOINTMENT (the formal creation of which is at present under contemplation) of a "SALES-ENGINEER" of rank equivalent to that of an Executive Engineer in the Indian Service of Engineers. He will be required to take charge of all commercial business connected with negotiations for the sale of hydro-electric power.

For further particulars apply to :—
W. N. McLEOD, Esq., B.Sc., I.S.E.,
Superintending Engineer,
Administration Circle, P.W.D.,
Hydro-electric Branch,
Benmore Simla-E.

Applications will be received up to 10 a.m. on August the 1st, 1927. 5661

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED by a Leading Engineering Insurance Company, additional BOILER INSPECTORS. Age 28 to 32. Applicants must be practical engineers with technical training, holding a first-class or extra first-class Board of Trade Certificate, capable of making accurately dimensioned sketches of all classes of steam boilers and writing clear reports on condition. Commencing salary £260 per annum.—Address, 5675, The Engineer Office. 5675 A

WANTED, Shrewd, Keen BUSINESS MAN, Able OUTDOOR REPRESENTATIVE. Good organiser; willing to help financially to carry through a revision of company allied to engineering. Must be able and successful traveller, good credentials. Fine opportunity.—Address in confidence, P3294, The Engineer Office. P3294 A

SITUATIONS OPEN (continued)

WANTED for the Federated Malay States, CHIEF ELECTRICAL ENGINEER, Associate or Full Member of I.E.E., to Take Charge of Steam Power Station (Turbo-alternators), High-tension Transmission System, Transforming Plant, Motors, &c. Applicants must be medically fit, having practical and administrative experience, age about 38. Three years' agreement, passage out and home, and free quarters. Salary £1000 per annum.—Applications, with full particulars of training and experience, references, and copies of testimonials, to Box 170, c/o Hooper and Batty, Ltd., 15, Walbrook, London, E.C. 4. 5666 A

AN ASSISTANT ENGINEER is REQUIRED for Supervising the Erection in the Bombay district of an E.H.T. Transmission Line and Overhead Track Equipment. Candidates should be about 30-35 years of age and have had some experience of work of this nature.—Apply in writing, giving full particulars of training and experience, age, salary required, &c., to MERZ and McLELLAN, 32, Victoria-street, Westminster, S.W. 1. 5660 A

CIVIL and MECHANICAL ASSISTANT ENGINEERS WANTED by a large Chemical Firm in the North of England. Must have had drawing-office experience.—Address, 5673, The Engineer Office. 5673 A

CONSULTING ENGINEER REQUIRES Intelligent TECHNICAL MAN to train as General Assistant. Age 25 to 30. Salary will not exceed £150 p.a. whilst training, after which it will be raised according to responsibility. State full particulars.—Address, P3279, The Engineer Office. P3279 A

CONTRACTOR'S ASST. for London. Building exp. essential. State fully experience, wages reqd.—Address, P3305, The Engineer Office. P3305 A

LOCOMOTIVE WORKS MANAGER.
Large Firm of Locomotive Manufacturers REQUIRE a thoroughly qualified WORKS MANAGER. Must have proved capacity of organisation and control and be well up in modern piecework production methods. Only those so qualified should apply. Good salary and prospects to the right man.—Address, in confidence, giving full particulars of experience and state salary expected, 5659, The Engineer Office. 5659 A

EXPERIENCED DESIGNER in REINFORCED CONCRETE REQUIRED for Concrete Specialists.—Address, stating full particulars of experience, age, and salary required, 5685, The Engineer Office. 5685 A

SITUATIONS OPEN (continued)

REQUIRED, WORKS MANAGER for Motor Works. Must be thoroughly experienced and capable of working in co-operation with Drawing-office on new design of engine. To a man of the right type an excellent salary will be paid.—Write, age, full particulars of qualifications and experience, &c., S. E., 6, Bloomsbury-street, W.C. P3248 A

STEEL FORGINGS AND CASTINGS.—Young ENGLISHMAN REQUIRED, about 25, with good technical training acquired in English steel works manufacturing steel castings and forgings of the highest quality, to Assist in the London Selling Agency of leading Continental Manufacturers of similar products. Applications are invited from qualified technical men only. Previous selling experience or connection not essential.—Write, with full statement of qualifications, where trained, and salary required, to Box 248, c/o Judd's, 47, Gresham-street, London, E.C. 2. 5684 A

WORKS MANAGER REQUIRED for Moderate-size Electric Works, North of England, manufacturing A.C. and D.C. motors and generators, also switchboards. Must be good organiser, with experience of modern production methods. Only those applicants who give full details of experience will be considered.—Address, stating salary required, 5686, The Engineer Office. 5686 A

WANTED, Capable DRAUGHTSMAN, Accustomed to Locomotive Boiler and Engine Work. Good opportunity for suitable man.—Address, stating age, experience, and salary required, 5674 The Engineer Office. 5674 A

WANTED, DRAUGHTSMAN; Good Knowledge of German essential. State age, education, experience, and salary required.—Address, P3282, The Engineer Office. P3282 A

WANTED, SEVERAL MECHANICAL DRAUGHTSMEN. Must be capable designers. None but first-class men need apply.—Address, stating age, experience, wage, &c., 5670, The Engineer Office. 5670 A

CRANE DRAUGHTSMAN WANTED; Must Have good experience of all types of Cranes and also first-class structural knowledge.—Address, stating age and salary required, 5664, The Engineer Office. 5664 A

For continuation of Small Advertisements see page 3.

JOHN OAKEY & SONS, LIMITED,

MANUFACTURERS.

GENUINE EMERY.
EMERY CLOTH.
EMERY CORUNDUM CARNET & FLINT TAPE
GLASS PAPER, BLACK LEAD.

FLINT AND CARNET PAPER.

N.B.—All Papers and Cloths are supplied in Rolls, Bands, Discs, Strips, and Sheets of almost any size and shape, to suit the special requirements of buyers. Prices quoted on receipt of particulars.

EMERY AND CORUNDUM DISCS

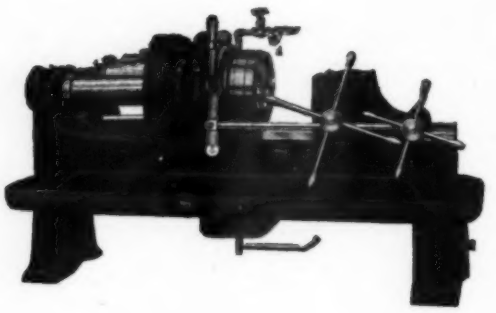
Of Cloth & Paper, for all Disc Grinding & Polishing Machines.

EMERY WHEELS

WELLINGTON WORKS, WESTMINSTER BRIDGE ROAD, LONDON, S.E. 1.

The Best—and British Throughout.

HEAP'S PATENT
SCREWING MACHINES
with tangential dies,



are the last word in Screwing Machines. They are designed from beginning to end as high class Machine Tools and embody features not found in any other make of Screwing Machine.

The Die Head is of entirely new design and Patents have been applied for.

The Tangential Dies are thread milled and hardened. When dull they can be simply re-ground and are then equal to new. They never require re-hobbing.

Responsible representatives of firms interested are invited to visit our Works to inspect the Machines in construction and completed, test them in actual use and prove their capabilities

Joshua Heap & Co., Ltd., Ashton-under-Lyne, England.

A Seven-Day Journal

The Birthday Honours.

IN the list of honours which were bestowed on the occasion of the King's Birthday on Friday last, we note with pleasure the name of Sir Charles Parsons, who is appointed to the Order of Merit in recognition of his eminent services in scientific research and its application to industry. Sir Davison Dalziel, who becomes a Baron, is known as the chairman of the Pulman Car Company, and he is also President of the International Sleeping Car Company. Sir Harry Renwick, who receives a baronetcy, is the chairman and managing director of the County of London Electric Supply Company, and is connected with several other important electricity undertakings. He is the author of more than one scheme for the electric supply of London. Mr. William Thorne, who receives a knighthood, is the secretary of the Dock and Harbour Board Authorities' Association. Engineers connected with work in India who receive the Order of the Indian Empire, C.I.E., include Mr. J. B. G. Smith, the official Chief Engineer of the Public Works Department, Irrigation Branch; Mr. J. A. Baker, Chief Engineer, Public Works Department, Buildings and Roads Branch, Central Provinces; Mr. C. S. Whitworth, Chief Mining Engineer to the Railway Board of Bengal; and Mr. A. B. Briggs, Superintending Engineer, United Provinces. At home in the Civil Division, Sir Frank Heath, late secretary to the Department of Scientific and Industrial Research, is made a G.B.E., and Lieut.-Colonel G. W. Humphreys, chief engineer to the London County Council, is made a K.B.E.

The Astronomer Royal's Report.

THOSE who have relied on the broadcasting of "Big Ben's" chimes for the accurate setting of their watches have, we think, come to recognise that faith cannot be placed in the signals to the last second or two. According to the report of the Astronomer Royal covering the year ending on May 10th, 1927, "Big Ben" was more than 3 seconds fast on nine days, between 2 and 3 seconds fast on 122 days, between 1 and 2 seconds fast on 164 days, and less than 1 second fast on 2 days. How it behaved on the remaining 68 days is not disclosed. For a time the clock was kept purposely about 2 seconds fast because its chimes were used as a warning for the Greenwich broadcast time signal. In Sir Frank Dyson's report we also read that the opening on June 6th, 1926, of the electrified services of the Southern Railway, which pass near Greenwich Observatory, led to the discontinuance at that establishment of the magnetic observations with the absolute instruments. The Abinger Station, near Dorking, Surrey, is now the standard magnetic observatory for the southern part of Great Britain. Another interesting passage in the report relates to the longitude determinations made by means of wireless signals in October and November, 1926, in accordance with the scheme drawn up by the International Astronomical Union. About fifty observatories took part in the tests, but all the information collected is not yet ready. Data are, however, given for the apparent longitude of Washington relatively to Greenwich as judged by wireless signals received from Bordeaux and Annapolis. During October the longitude of Washington as judged by the signals from Bordeaux was 5 h. 8 m. 15·737 s., and as judged by the signals from Annapolis 5 h. 8 m. 15·784 s. The difference of 0·047 s. is closely explained by the known velocity of propagation of wireless waves and is approximately twice the travel time across the Atlantic. During November the Bordeaux figure was 5 h. 8 m. 15·720 s. and the Annapolis figure 5 h. 8 m. 15·772 s. The difference, 0·052 s., is much the same as the October difference and is to be explained in the same manner. The differences of 0·017 s. in the two Bordeaux figures and of 0·012 s. in the two Annapolis figures are not commented upon, but they may represent a secular variation of longitude, the discovery of which was, we may recall, one of the objects of the tests. The variation represented by the figures, if they can be so interpreted, would correspond with a movement of about 20ft.

New Motor Vessels.

ON Thursday of last week, June 2nd, there was launched from the Dalmuir Yard of William Beardmore and Co., Ltd., the twin-screw motor vessel Itapé, the first of three passenger and cargo-carrying ships which the firm is constructing to the order of the Companhia Nacional de Navegacao Costeira, of Rio de Janeiro. The Itapé has a length between perpendiculars of 370ft. with a breadth moulded of 52ft. and a depth moulded of 26ft. 9in. She is designed to carry 3800 tons deadweight, at a loaded draught of 20ft. and measures about 5000 gross tons. Accommodation is provided for 145 first-class passengers, 40 passengers of intermediate class, and 90 third-class passengers, for which there are suitably designed public rooms, state rooms and cabins. Five cargo holds are provided for general and refrigerated cargo. The propelling machinery is of especial interest, as it will be the first installation of supercharged oil engines constructed in Great Britain. It will consist of two Beardmore-Tosi oil engines of the four-stroke cycle single-acting type, which have been designed to develop a total of 3600 B.H.P. when supercharged. The special features of the Beardmore-Tosi valve gear have been developed to utilise to the fullest extent the advantages to be obtained from supercharging. Each main engine will have six cylinders with a bore of 26in. and a stroke of 43½in. The engine-room auxiliaries will be partly electrically driven and partly steam driven, the current being supplied by steam-driven generators. Two donkey boilers are provided, which will raise steam for deck auxiliaries and also for the electric generating sets. At the Clyde Yard of the Blythswood Shipbuilding Company, Ltd., at Scotstoun, orders have been received for two motor oil tankers of 10,000 and 11,000 tons deadweight carrying capacity for Liverpool owners. The propelling machinery is to be supplied by John G. Kincaid, Ltd., of Greenock, and will consist of Kincaid-Harland-B. and W. type oil engines designed to give the vessels a speed of about 11½ knots.

The Samuel Crompton Centenary.

DURING the past week the town of Bolton has celebrated the centenary of the death of Samuel Crompton, the inventor of the spinning mule, who was born in Bolton in 1753 and made his invention in 1779. The cotton trade undoubtedly benefited by the genius of the inventor, but he himself made little profit from the invention, and he died, a disappointed man, in very humble circumstances. An exhibition at the Technical School, which was opened on Wednesday last, illustrates the evolution of spinning and the great contributions to its progress which in the past were made by Hargreaves, Arkwright and Crompton. The actual machine made by Crompton was to be seen working alongside examples of the modern self-acting mule, and varied machinery of modern design which is now used in the textile trades. Over £3000 worth of new textile machinery has been presented to the Bolton Technical College to mark the centenary celebration. The proceedings were international in character, and besides leading representatives of the home textile trades and textile engineering firms, there were present some forty delegates from over fourteen foreign countries, who visited the town of Bolton on the occasion of the centenary celebrations and attended the annual conference of the Textile Institute. It will be recalled that the late Viscount Leverhulme bought and presented to Bolton Crompton's house, "Hall i' th' Wood," where he lived and where his spinning mule was built. The Bolton Museum has also recently acquired important Crompton letters and papers relating to the early development of the spinning mule, which include a detailed census by Crompton of the number of spindles, mule, jenny and throstle which were in use in the year 1811.

Wireless Stations for Bulgaria.

FOR the purpose of placing Bulgaria in direct communication with England, Austria and other European countries, the Bulgarian Government has decided to establish wireless transmitting and receiving stations, and the contract for the work has been awarded to Marconi's Wireless Telegraph Company. A station at Sofia will be equipped with a high-speed transmitter, with a wave length range of 36 m. to 72 m., and a high-speed long wave combined telegraph and telephone transmitter. The former will be used for communication with stations operated in England, through which Sofia will be in touch with the principal cities of the world, whilst the other transmitter, which will have a wave length range of from 2000 m. to 4000 m., will serve for communication with Vienna. For the receiving station a set of high-speed commercial receivers with a combined overall wave length range of from 1200 m. to 25,000 m., will be employed; also a short-wave non-radiating receiver with a wave length range of from 15 m. to 100 m.

The Argentine Navy.

THE naval forces of the Argentine Republic are to be considerably augmented within the near future. As reported in our previous issue, two fast cruisers of 6000 tons have been ordered in Italy. It has since been announced that a contract for three flotilla leaders of powerful type is to be executed by J. Samuel White and Co., Ltd., of Cowes, this order having been secured in the teeth of keen competition, especially from continental firms. All the foregoing vessels are due for delivery in two years, but meanwhile the Argentine Government has purchased from Spain two flotilla leaders which were recently completed for the Spanish Navy. These are the Churruca and Alcala Galiano, built at Cadiz and launched in June and November, 1925, respectively. They bear a close resemblance to the British leaders of the "Scott" class, and were, in fact, designed under British supervision. The type has a length of 320ft., a breadth of 31¾ft., and a draught of 10¼ft., the normal displacement being 1650 tons. The machinery, consisting of two sets of Parsons turbines, is designed for 42,000 S.H.P. and 36 knots. With 540 tons of oil in the bunkers the cruising radius at economical speed is 4500 miles. The armament comprises five 4·7in. guns, one 14-pdr. A.A. gun, and six 21in. tubes triply mounted. The steam trials of the Churruca, held in April, 1926, proved remarkably successful. On a full-power run she averaged 37·64 knots, the maximum speed attained being 39·76 knots. The price paid for these vessels has not been revealed, but is stated to be equal to the first cost of having them built in Great Britain. They are to be paid for out of a loan of £3,640,000 which the Argentine Government recently negotiated with Spain.

Another Transatlantic Flight.

CLOSELY following Captain Lindbergh's flight of 3625 miles, from New York across the Atlantic to Paris without a stop, another American machine, a Columbia monoplane, piloted by Mr. Clarence Chamberlin and carrying Mr. Charles Levine as passenger, succeeded in repeating and even excelling the performance. Mr. Chamberlin left New York at 11.4 a.m. on Saturday, June 4th, and flying by way of Newfoundland and the extreme south-west of England, he alighted with all his petrol exhausted at Eisleben, a small town about 100 miles south-west of Berlin, at about 5.30 a.m. on Monday, June 6th. The distance covered is estimated at 3905 miles. The machine used closely resembles the Ryan monoplane used by Captain Lindbergh, and, like that machine, is distinguished by the completely enclosed cockpit in which the pilot sits. The engine, as in the case of the Ryan monoplane, is a Wright "Whirlwind" air-cooled engine of 200 horse-power. The machine has an economical cruising speed of 110 miles an hour, and when it left New York had on board about 425 gallons of petrol. It had previously been tested in America by flying continuously over Long Island for a period of 51 hours 11 minutes.

An Extended R.A.F. Flying Boat Cruise.

FURTHER particulars are now available as to the composition and *personnel* of the Royal Air Force flight of flying boats from Great Britain to Singapore and on to Australian waters which was recently arranged. Four boats of the Supermarine Southampton type with metal hulls are to be employed, which are fitted with two Napier-Lion engines, each designed to develop 450 horse-power. The commander will be Group-Captain H. M. Cave-Brown-Cave, with Squadron-Leader G. E. Livock, of the Flying Boat Development Flight, Felixstowe, as the second officer in command, with a *personnel* of five flight-lieutenants and three flying officers. It is expected that a considerable saving in weight will be attained by using metal-hulled machines, while the absence of water soakage, which would take place with wooden hulls, will be another factor operating in the direction of a greater duration of flight than has hitherto been attained. The hulls of the new machines are roomy, and are provided with a navigator's chart table, a wireless operator's room, and control and gunnery cockpits. Collapsible bunks are supplied, so that there is sleeping accommodation for the crew. It is expected that the boats will be flown out over the Mediterranean to India and on to Singapore. The flight will be continued along the Dutch East Indies to the Australian coast, where a coastal flight in conjunction with the Royal Australian Air Force will be carried out.

Wages in the Engineering Trades.

IN a Journal note published in our issue of May 27th we gave in outline the result of the conference held on May 19th, between the Engineering and Allied Employers' National Federation and the representatives of the various trade unions associated with the engineering industry. It will be recalled that offers were made on both sides, but no basis for agreement was found. A further effort to reach a settlement of the unions' claim for an advance in wages, on a national basis, was made on Thursday of last week, June 2nd. Mr. J. T. Brownlie and Mr. Frank Smith, the chairman and secretary respectively of the Joint Negotiating Committee, then met Sir Allan Smith, the chairman of the Employers' Federation, to ask for another conference to discuss the position. Mr. Brownlie reported that the National Committee of the Amalgamated Engineering Union had decided to continue the negotiations in order to secure, if possible, an advance in excess of the employers' offer of May 19th. That offer, it will be remembered, was an advance of 2s. 6d. per week on condition that a modification should be made in the rates for overtime and night shifts, or alternatively an unconditional offer of 2s. per week for plain time workers, provided wages were stabilised for one year. Sir Allan Smith gave consideration to the reports which were made on behalf of the unions, and it was agreed to call another joint conference in London for Tuesday morning, June 14th.

Tests of a 2-8-4 Type Locomotive.

By E. C. POULTNEY.

SERVICE TEST ON THE BOSTON AND ALBANY RAILWAY.

IN THE ENGINEER of October 23rd, 1925, there appeared an article by the writer which described a locomotive of novel design for handling heavy goods trains and constructed with the express object of hauling trains of considerable weight at speeds in excess of those prevailing with such loads, thereby increasing the ton miles obtainable per hour, and at the same time producing these results with economy in the fuel consumed per unit of power developed at the draw-bar.

The present article is written in order to present the working results given by this engine under service conditions, and is founded on data compiled by the locomotive department of the Boston and Albany Railroad from road trials made under the direction of Mr. F. A. Butler, Superintendent of Motive Power and Rolling Stock.

THE LOCOMOTIVE.

It will be remembered that the chief features of this 2–8–4 locomotive are its large grate and fire-box, the adoption of the restricted cut-off system of working, and a high steam pressure of 240 lb. per square inch, which constitutes a necessary factor when a limited admission rate is used, in order to produce the tractive effort required with the mean pressure reduced by a relatively early cut-off. At the expense of some recapitulation, the leading dimensions of the engine are repeated :—

Total weight, engine only, lb.	385,000
Weight on coupled axles, lb.	248,200
Cylinders, diameter and stroke, inches	28 by 30
Wheels, drivers, diameter, inches	63
Heating surfaces—	
Tubes and flues, square feet	4,773
Fire-box, square feet	284
Arch tubes, square feet	53
Total evaporative, square feet	5,110
Superheater, square feet	2,110
Total combined, square feet	7,220
Grate area, square feet	100

The figures given measure the heating surfaces on the water side of the evaporative surfaces and on the steam contact area of the elements of the type E superheater.

The engine is equipped with a mechanical stoker of the Elvin design, a feed-water heater of the closed type, with its attendant pump, and these, together with the Westinghouse compressors, stoker, grate shakers, blower, and headlight generator, are supplied with superheated steam, as is also the booster.

The maximum cut-off is 60 per cent. in full gear, and the valves have a maximum travel of 8¾in. with a steam lap of 2 7/16 in. and a lead of ¼in. There is exhaust clearance to the extent of 1/16 in. The maximum tractive effort without the booster is 69,400 lb.

TEST EQUIPMENT.

In order to carry out the tests the New York Central dynamometer car, having a capacity of 500,000 lb. draw-bar pull, was coupled between the locomotive and the train. Indicators were fitted to the cylinders, water gauge glasses were fixed to the tender tank, which was calibrated, and provision was made for measuring the coal fired by means of a slope-bottom coal-box mounted on platform scales and carried on the tender.

Steam gauges were applied to the dome, the saturated and superheated sides of the superheater header, to the steam chest, to the exhaust passage, to the steam space in the feed heater, to the feed water connection at the boiler check valve, and to the steam piping to and from the booster. Thermometers were inserted in both steam pipes close to the steam chests and to the left side exhaust passage. Thermometers were also fitted in the tender tank, in the water pipe to and from the heater, in the exhaust steam piping to the feed-water heater, and to the condensate line from the heater. Pyrometers were used to indicate the temperature of the superheated steam and that of the smoke-box. Provision was made to read the draught in the fire-box and in the smoke-box in front of and behind the diaphragm.

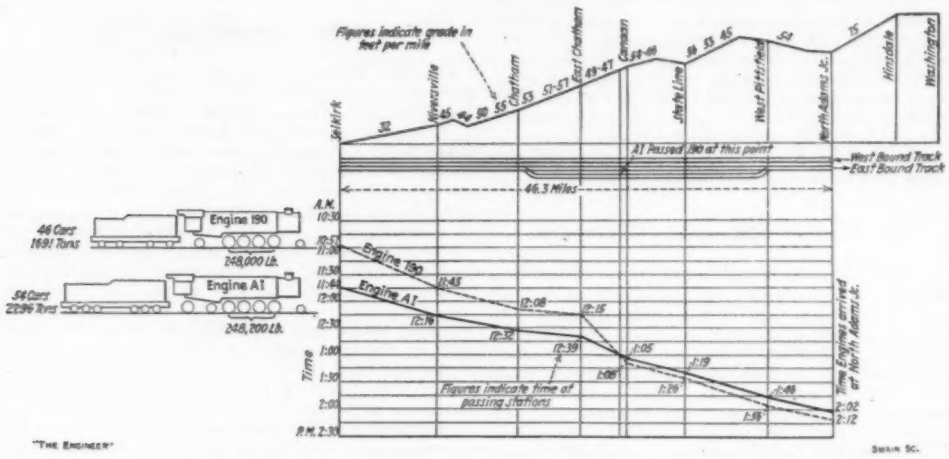


FIG. 1—CONDENSED GRADIENT SECTION OF LINE USED FOR TESTS

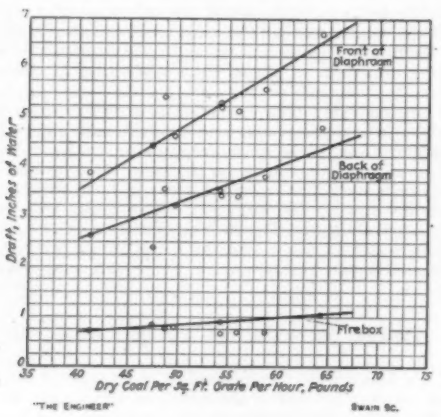


FIG. 2—RATIO OF COAL CONSUMPTION TO DRAUGHT

The trial runs to be delineated were made on the Albany division between Selkirk, N.Y., and Springfield, Mass., the distance being about 100 miles. They were made going east from Selkirk to Washington, which is at the summit of a gradient and distant from the start 60 miles. A condensed gradient section is given by Fig. 1, which also gives certain information relative to a special test to be mentioned later.

There is a considerable volume of traffic over this section and normally the passenger and goods tonnage to be handled closely approaches the capacity of the line. Any increase, therefore, in the tonnage of trains and in their operating speed is desirable as a means of relieving this congestion. It will be noted that the 60 miles are for the most part on rising gradients, which average approximately 50ft. per mile, or 1 in 105. Between March 28th and April 18th, 1925, nine reliable test runs were completed. The results obtained are given in the succeeding tables. All the trials were made under normal operating conditions; they give, therefore, the locomotive performance in regular service, and thus enable the engine working to be gauged from the standpoint of average train operation over this particular section of the line. All the figures given are the mean of readings made over each run and cover the effect of power outputs from the maximum to the minimum which go to make up the average, and further, the means of all these results are summarised in the last line of each table.

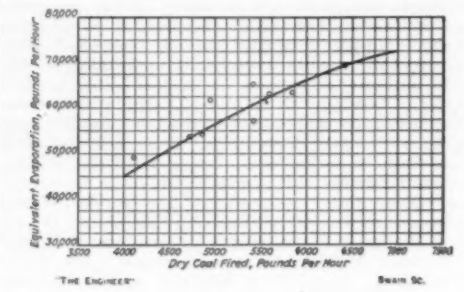


FIG. 3—EVAPORATION CURVE

BOILER AND SUPERHEATER PERFORMANCE.

Fuel.—Bituminous coal with a value varying from a maximum of 13,913 to a minimum of 12,868 B.Th.U. "as fired" was employed, the mean value being 13,282 B.Th.U. The B.Th.U. per pound of this fuel "dry" ran from 14,055 to 13,500, the mean value on that basis being 13,833 B.Th.U. The ash percentage in the dry coal varied between the limits of 12·25 and 8·52, the mean being 10·29.

Firing.—Throughout the trials practically the whole of the coal fired was handled by the Elvin mechanical stoker. The number of scoops fired by hand averaged twenty-seven for the nine different tests, the greatest quantity for any given run being forty-seven and the minimum five.

Feed Heater and Boiler Feed.—When the locomotive was working, the feed was supplied by the pump and heater entirely, and when standing the injector was employed. The lowest temperature of the cold water entering the heater was 68 deg. Fah. and the highest 76·5 deg., whilst the average for the tests was 73·1. The temperatures of the hot feed varied between a maximum of 210 deg. and a minimum of 207 deg. Fah., and the mean value was 207·6 deg.

Draught and Fuel Rate.—The draught in inches of water in the fire-box and before and behind the diaphragm in the smoke-box is shown in Table I. and graphically by Fig. 2, when burning 6423 lb. of dry coal per hour the draught readings were 6·70in. at the front of the diaphragm and at the fire-box 1·04in. On the basis of the firing rate of 64·2 lb. of fuel per square foot of grate per hour, this figure appears to

TABLE I.—*Combustion and Draught.*

Test No.	Duration of test, hours.	Coal per hour, total lb.	Coal per square foot of grate per hour.	Coal per square foot of combined heating surface per hour.	Draught readings. Fire-box.	Front of diaphragm.	Back of diaphragm.
25 51 10	3·48	5427	54·27	0·752	0·67	5·22	3·46
25 51 12	3·22	4871	48·71	0·675	0·76	5·43	3·58
25 51 14	3·33	4112	41·12	0·570	0·70	3·90	2·61
25 51 16	3·13	4730	47·30	0·656	0·83	4·44	2·38
25 51 18	2·28	4957	49·57	0·687	0·78	4·63	3·24
25 51 20	2·87	5420	54·20	0·751	0·90	5·30	4·05
25 51 22	2·95	6423	64·23	0·890	1·04	6·70	4·83
25 51 24	2·83	5597	55·97	0·773	0·69	5·15	3·42
25 51 26	3·46	5856	58·56	0·811	0·69	5·59	3·82
Mean	3·12	5266	52·66	0·730	0·78	5·15	3·49

TABLE II.—*Combustion and Evaporation.*

Test No.	Fuel B.Th.U., dry.	Value B.Th.U. as fired.	Coal per sq. ft. of grate per hour.	Coal per sq. ft. of comb. heat. surface per hour.	Equivalent evaporation per hour.	Equivalent evaporation per pound coal.	Equivalent evap. per sq. ft. comb. heat surface.	Efficiency, boiler feed heater and superheater.
25 51 10	14,050	13,400	54·27	0·752	57,171	10·534	7·92	72·75
25 51 12	13,773	13,254	48·71	0·675	54,273	11·140	7·50	78·49
25 51 14	13,884	13,390	41·12	0·570	49,208	11·966	6·81	83·63
29 51 16	13,500	12,894	47·30	0·656	53,729	11·360	7·44	81·66
25 51 18	13,500	13,015	49·57	0·687	61,729	12·452	8·55	89·51
25 51 20	13,294	12,868	54·20	0·751	65,343	12·034	9·04	87·84
25 51 22	13,915	13,452	64·23	0·890	69,320	10·790	9·59	75·25
25 51 24	14,055	13,913	55·97	0·773	63,111	11·277	8·75	77·86
25 51 26	13,525	13,368	58·56	0·811	63,333	10·816	8·77	77·60
Mean	—	—	52·66	0·730	60,690	11·370	8·44	80·5

compare favourably with results obtained in good practice, whilst on the basis of the total coal fired for a given draught the result is remarkable, and is, of course, due to the large grate, whilst the difference between the two readings indicates that the net gas areas through the tubes and flues are ample. This figure is 10·5 square feet, or 10·5 per cent. of the grate surface. The tubes and flues are 20ft. long between the tube sheets, those containing the superheater elements being 3½in. and the fire tubes 2¼in. outside diameter.

The advantage of a large grate and hence the relatively low rate of combustion for a given power is evident from these curves. From the run of the lines the draught required increases rapidly as the rate of firing increases, and as draught is a measure of back pressure it is seen that, for a given quantity of coal, and therefore for a given power output, there must be

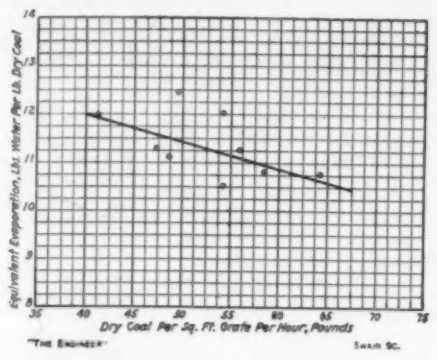


FIG. 4—WATER - COAL RATIO

a reduction in the energy absorbed by the blast and from that an increase in the cylinder efficiency. Actually for an output of 2367 I.H.P. test 25–51–22 the draught reading was but 6·70in. of water at the smoke-box.

Evaporation and Superheat.—The total equivalent evaporations or boiler output is given by Fig. 3, whilst Fig. 4 shows the water-coal ratio and firing rate, and Table II. sets out the fuel values, firing rates, the evaporations realised, and also the boiler efficiencies; the latter figures are inclusive of the feed heater and the superheater.

When burning coal at an average rate of 6423 lb. per hour, equal to 64·23 lb. per square foot of grate and 0·890 lb. per square foot of combined heating surface, the equivalent evaporation per pound of dry fuel works out to 10·79 lb., and the steam plant

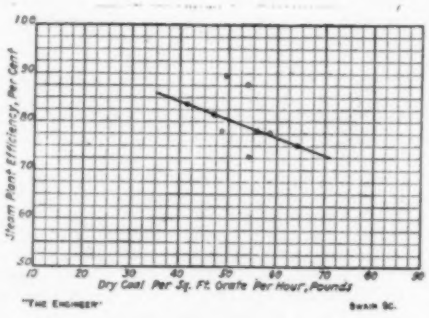


FIG. 5—EFFICIENCY CURVE

efficiency is 77·86 per cent. The mean efficiencies for all the tests are shown by Fig. 5.

The superheat attained is given by Table III.,

TABLE III.—*Steam Pressures and Temperatures.*

Test No.	Steam pressures. At boiler.	Steam pressures. At steam chests.	Temperatures. At superheater header.	Temperatures. At steam chest, deg. of sup'h't.	Temperatures. Smoke-box temp.
25 51 10	227	208	652	205	569
25 51 12	224	209	650	194	521
25 51 14	227	195	637	190	543
25 51 16	226	202	639	195	556
25 51 18	224	204	660	216	577
25 51 20	231	211	663	213	562
25 51 22	231	211	672	236	599
25 51 24	224	203	665	220	585
25 51 26	216	201	659	210	582
Mean	225	205	655	209	571

which also includes the smoke-box temperatures, which, it will be noted, are remarkably uniform, varying only within the limits of 543 deg. and 599 deg., and thus clearly indicate the ability of this boiler to absorb the heat liberated by the furnace. The steam temperatures follow the rate of evaporation, and even when the average pressure was as high as 231 lb. the superheat at the header was about 264 deg. Fah., the highest average figure recorded. The equivalent evaporation was 69,320 lb. per hour. The superheating surface is 2110 square feet, or 29·2 per cent. of the total, and 41·2 per cent. of that contributed by the tubes, flues, and fire-box.

Steam Pressures and Temperatures.—The average steam pressures and the steam temperatures for the tests are also shown in Table III. The maximum working pressure was 240 lb. and the mean pressures attained varied from 216 lb. to 231 lb., whilst the average for the nine trials was 225 lb., equal to 93·8 per cent. of the maximum. This table also gives the relative pressures in the dome and at the steam chests, and so indicates the pressure loss through the superheater; the average difference for all the runs was 20 lb. The regulator or throttle was full open during the different tests. With the throttle opening constant the variables influencing the pressure drop through the superheater elements are the working speed and cut-off, and particulars of these conditions will be found in Table IV., where data concerning the power developed are given.

Having in the foregoing considered the boiler and superheater performance, attention may now be directed in what follows to the behaviour of the engines and the locomotive as a whole. The general results of a competitive trial between the 2–8–4 engine and one of the 2–8–2 type will also be given.

Power and Steam and Coal Rates.—Table IV. gives particulars of the cylinder horse-powers (I.H.P.) together with the speed in miles per hour, revolutions per minute, and piston speeds, the two latter having been added to the original data. Then come particulars of the cut-offs, I.H.P. steam conditions, pressure and superheat, and the steam and coal rates, these being the amounts chargeable to the engines. Further information as to the steam and fuel consumptions are given by Figs. 6 and 7, which show the consumptions based on the amount charged to the engines, and also when account is taken of that consumed by the auxiliaries. The average indicated horse-power for the nine different runs varied from 1706·0 to as high as 2367·8, and the mean for all tests was 1923·7. The total combined heating surface is 7220 square feet, so that the amount of heating surface per I.H.P. is 4·2, 2·88, and 3·54 square feet.

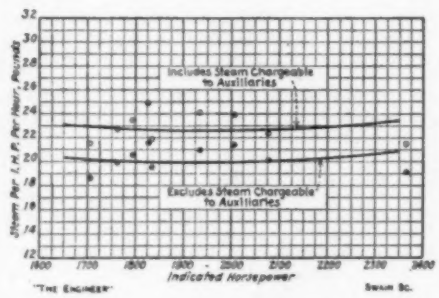


FIG. 6—STEAM - INDICATED HORSE POWER CURVES

During the trials the highest I.H.P. recorded was 3675, equivalent to 1·96 square feet of heating surface per unit of power developed at the cylinders. The lowest steam rate was 18·60 lb. and the highest 21·55 lb. per I.H.P. hour.

In order that the working conditions bearing directly upon the steam rates may be better seen, the piston speeds have been added, as already mentioned, these, together with the cut-offs, influence the steam consumption; superheat also governs the cylinder economy, but its effect is obscured. Trials have repeatedly shown that, for any given locomotive, high economy is not necessarily accompanied by high superheat, and it seems that the results obtained from the present locomotive are not contradictory in this respect. This is, of course, no argument against superheat, because it is certain that were saturated steam used the water rates would be much higher.

The phenomenon of low steam temperature and high economy is due to the boiler evaporative conditions prevailing, because early cut-offs and high speeds reduce the steam demand per unit of power, and the necessary fall in evaporation reduces the possible superheat for a given superheater.

The steam and coal rates are remarkably uniform for all the tests, and the latter run from a maximum of 2·67 lb. to a minimum of 2·36 lb., whilst the mean is 2·44 lb. of dry coal per I.H.P. hour, or, including that consumed by the auxiliaries, the maximum is increased to 3·03 lb. and the minimum to 2·66 lb.

TABLE IV.—*Indicated Horse-power, Steam and Coal Rates.*

Test No.	Working speed, m.p.h.	Speed, r.p.m.	Piston speed.	Cut-off, per cent.	I.H.P.	Steam chest pressure.	Steam chest superheat.	Steam per I.H.P. hour.	Coal (dry) per I.H.P. hour.
25 51 10	13·25	71·2	356	46·0	1795·5	208	205	20·58	2·67
25 51 12	15·76	84·4	421	41·5	1835·4	209	194	19·41	2·36
25 51 14	14·42	77·2	386	35·2	1706·0	195	190	18·60	2·37
25 51 16	15·63	83·2	417	41·0	1763·5	202	195	19·94	2·37
25 51 18	18·18	100·6	503	39·5	1826·9	204	216	21·55	2·34
25 51 20	17·67	94·4	472	45·0	2007·1	211	213	21·38	2·41
25 51 22	16·84	90·0	450	48·5	2367·8	211	236	19·09	2·41
25 51 24	18·03	96·2	482	43·0	2077·3	203	220	20·06	2·42
25 51 26	14·79	79·0	395	54·0	1934·9	201	210	20·85	2·62
Mean	16·16	86·4	432	43·7	1923·7	205	209	20·16	2·44

and the mean becomes 2·76 lb. Similarly, the maximum, minimum, and average steam rates are 24·91 lb., 21·42 lb., and 22·92 lb. per I.H.P. hour.

The next Table, No. V., gives particulars of the power developed at the tender draw-bar together with the steam and coal rates, auxiliaries excluded, and the locomotive machine efficiency, that is, the percentage of the cylinder power available at the rear of the tender. In the last column the overall efficiency is given.

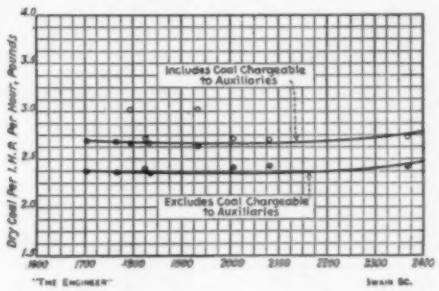

Includes Coal Chargeable to Auxiliaries
Excludes Coal Chargeable to Auxiliaries
Dry Coal Per I.H.P. Per Hour, Pounds
"The Engineer"
Swain Sc.

FIG. 7—COAL - INDICATED HORSE POWER CURVES

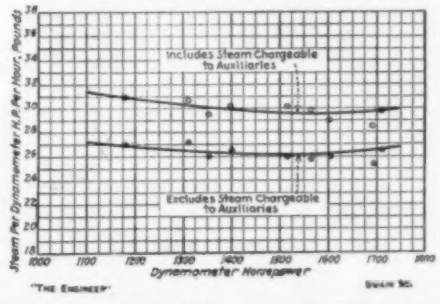


FIG. 8—STEAM - DRAW - BAR HORSE POWER CURVES

Figs. 8 and 9 show how the steam and fuel consumptions vary with the power output of the locomotive, and indicate the difference between the consumptions per unit of power, including and excluding the water and coal charged to the auxiliaries.

The mean dynamometer horse-powers developed, as shown by the table, range from 1179·1 to 1711·6, with an average for the tests of 1481·4. The power absorbed by the locomotive itself is therefore 526·9, 356·2, and 442·3 horse-power under the above conditions. The coal rates and the steam rates are again very uniform, and throughout the tests the consumption of dry coal per draw-bar horse-power per hour

TABLE V.—*Draw-bar Pull, Horse-power, Steam and Coal Rates and Efficiencies.*

Test No.	Pull.	D.B.H.P.	Steam per D.B.H.P.	Coal per D.B.H.P.	Machine efficiency.	Locomotive efficiency.
25 51 10	35,350	1399·7	26·41	3·41	82·4	4·67
25 51 12	31,150	1310·8	27·18	3·30	79·7	4·98
25 51 14	29,500	1179·1	26·90	3·03	77·4	5·07
25 51 16	32,450	1354·2	25·97	3·08	79·7	5·39
25 51 18	31,216	1515·2	25·08	2·83	82·9	5·77
25 51 20	36,000	1693·6	25·33	2·86	83·2	5·99
25 51 23	38,067	1711·6	26·40	3·34	80·6	4·88
25 51 26	33,300	1603·1	25·99	3·13	79·2	5·19
25 51 26	39,650	1565·8	25·76	3·23	83·4	5·03
Mean	34,076	1481·4	26·21	3·13	80·2	5·22

did not exceed 3·41 lb., the minimum figure is 2·83 lb. and the mean 3·13 lb. When it is considered that the engine was operating with a mean cut-off of 43·7 per cent. and at 16·16 miles per hour with a piston speed of but 432ft. per minute, these results appear to be satisfactory.

Efficiencies.—The machine efficiency, which averaged 80·2 per cent., may be considered low, keeping in mind the speed, but the effect of gradient resistance must be remembered, because it detracted considerably from the available power at the drawbar. The overall efficiency—Fig. 10—was also adversely influenced, so that whilst these figures indicate the result of heavy train working on fairly stiff gradients, and as such are instructive, they cannot be taken as being illustrative of the efficiency of the modern locomotive in a general sense, though they most decidedly

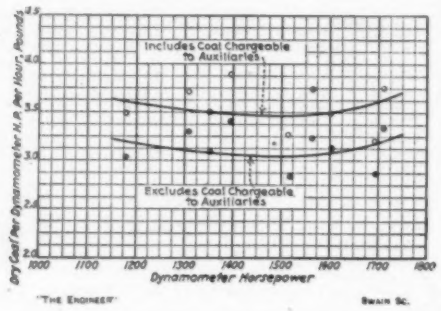

Dry Coal Per Dynamometer H.P. Per Hour, Pounds
Includes Coal Chargeable to Auxiliaries
Excludes Coal Chargeable to Auxiliaries
1000 1100 1200 1300 1400 1500 1600 1700 1800
Dynamometer Horsepower
"The Engineer"
Brain Sc.

FIG. 9—COAL-DRAW-BAR HORSE POWER CURVES

show how gradient and locomotive weight together influence the overall efficiency of the unit as a power plant.

Comparative Tests.

Some reference has been made to the general traffic conditions over the length of line on which these tests were made, and keeping in mind the idea with which the locomotive No. A1 of the 2–8–4 type was built, namely, that of increasing the power output—that is, the dynamometer horse-power which is proportional to the ton-miles per hour possible—the following tests will be of interest.

This trial was made to establish the power difference between the standard "Mikado" type goods engines in traffic and the new 2–8–4 design. A general comparison of the chief dimensions of these locomotives will be found in THE ENGINEER of October 23rd, 1925. Fig. 1 shows clearly the results obtained,

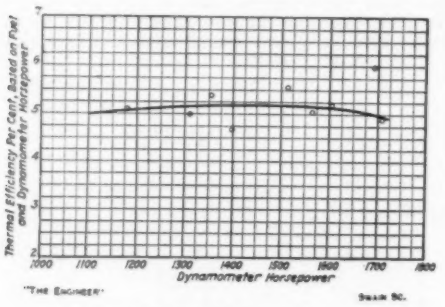

Thermal Efficiency Per Cent. Based on Fuel and Dynamometer Horsepower
1000 1100 1200 1300 1400 1500 1600 1700 1800
Dynamometer Horsepower
"The Engineer"
Brain Sc.

FIG 10—OVERALL EFFICIENCY CURVE

whilst Table VI. gives particulars of the powers developed, and the fuel used per hour, per horse-power and per square foot of grate per hour. The "Mikado" hauled a train of forty-six cars, equal to

TABLE VI.—*Comparative Fuel and Power Data, 2–8–4 and 2–8–2 Locomotives.*

Average dry coal fire, pounds per hour.	2–8–4 engine.			2–8–2 engine.		
	Coal per sq. ft. of grate.	D.B. H.P.	Coal per D.B. H.P.	Coal per sq. ft. of grate	D.B. H.P.	Coal per D.B.H.P.
4000	40	1200	3·33	—	—	—
4500	45	1350	3·33	—	—	—
5000	50	1480	3·38	75·2	1200	4·16
5500	55	1600	3·43	82·9	1250	4·40
6000	60	1750	3·43	90·4	1320	4·53
6500	—	—	—	97·7	1420	4·57
7000	—	—	—	105·1	1550	4·51
7500	—	—	—	113·0	1650	4·54

1691 tons, and the 2–8–4 had fifty-four cars, equal to 2296 tons.

The "Mikado" No. 190 started 47 minutes before the engine A1. Both trains ran without delays, and A1 passed No. 190 at the point given on the diagram. The time distance curves show distinctly how even was the speed maintained by the new engine. Nominally, the rated tractive force of these two engines is much about the same, the increase in favour of A1 being only 5900 lb.—say, 10 per cent.—and the adhesive weight of the 2–8–4 is but 200 lb. greater than that of No. 190, yet it hauled a train 36 per cent. greater in weight in 57 minutes less, or 70 per cent. of the time taken by the 2–8–2 engine.

Engine No. 190 performed 78,293 ton-miles in 3·25 hours, or 24,690 ton-miles per hour, and No. A1 at the same time and under equal conditions performed 106,304 ton-miles, or 46,300 ton-miles per hour; thus on a time basis A1 developed 88 per cent. more ton-miles.

Table VI. shows that, whereas A1 did not burn more than 6000 lb. of dry coal per hour, No. 190 reached a maximum of 7200 lb., the dynamometer horse-powers being respectively 1750 and 1650 and the coal rates 3·43 lb. and 4·54 lb. per D.B.H.P. hour.

General Performance of the Locomotive.

So far as the several new features incorporated in the design of A1 are concerned, the report makes the following observations:—

Tractive Force.—The rated maximum tractive force of 69,400 lb. was obtained at slow speeds, and the driving wheels weight of 248,200 lb., giving an adhesive factor of 3·58, was found adequate; "there was no more tendency to slip than there would be with a full-stroke engine having the same driving wheel load and developing 63,500 lb. tractive force." With a 60 per cent. maximum cut-off a factor of 3·58 was as good as a factor of 3·92, owing to the even turning moment realised with the limited cut-off. Starting was prompt under all conditions.

Motion.—The maximum piston load of 148,000 lb. had no ill effect on the motion parts. The wear was shown to be equalised throughout the axle-boxes, thus confirming the theory that the special main and side road drive adopted would distribute the stresses equally.

Fire-grate.—Observations showed that proper combustion under light loads could be supported on the grate. The firing rate could be as low as 41 lb. per square foot of grate surface.

General Summary.

Based on the average results for all the tests, the following additional computations are presented.

Steam Production.

Feed Heating System.—The mean temperature of the water entering the heater was 73 deg. Fah., corresponding to 40·05 B.Th.U., and the hot feed averaged 207·6 deg., or 174·97 B.Th.U., so that the B.Th.U. added to each pound of feed water was 133·92. The actual total evaporation was 44,091 lb. per hour, or 734·85 lb. per minute; this figure being equal to the water rate per I.H.P. hour inclusive of that chargeable to the auxiliaries multiplied by the mean power developed, and estimated on this amount the feed heater generated 98,404·4 B.Th.U. per minute. The total heat above the feed temperature in the superheated steam is 1300·15 B.Th.U., and of this the feed heater furnishes 133·92 B.Th.U., so that the direct saving due to the heater is (133·92 ÷ 1300·15) × 100, or 10·3 per cent.

Boiler.—The boiler steam pressure averaged 225 lb. for the tests and the total B.Th.U. produced amounted to 1025·93 × 44,091 ÷ 60, or 733853·8 B.Th.U. per minute, and as the total evaporative heating surface is 5110 square feet the heat transfer per square foot per minute is 147 B.Th.U. and the actual water evaporated per square foot of heating surface is 8·6 lb. per hour.

Superheater.—The superheater maintained an average steam temperature of 455 deg. Fah., and as that of the steam in the boiler was 397·3 deg., the actual superheat added averaged 257·7 deg. Fah. Assuming that the value of the superheated steam is taken at 1341·2 B.Th.U., the work done by the superheater was 1341·2 − 1200·9, or 140·3 B.Th.U. per pound of steam generated and passed to the engines, and the auxiliary plant. The total water used being 44,091 lb., the total heat generated by the superheater per minute is represented by 44,091 × 140·3 ÷ 60, or 103092·4 B.Th.U. per minute, or about 13 per cent. of that furnished by the boiler. The heating surface of the superheater is equal to 41·2 per cent. of that of the boiler, and forms 29·2 per cent. of the total combined heating surfaces. The heat transfer per minute is 48 B.Th.U. and the ratio of proportion of the heat transfer across the evaporative surface to that transferred across that of the superheater is 48 ÷ 147 × 100, or 32·6 per cent.

One square foot of superheating surface transfers approximately 33 per cent. of that transferred per square foot by the water heating surfaces. The total heat generated per pound of feed water above 73 deg. Fah. averaged 1300·15 B.Th.U., divided as follows:—

		Per cent.
B.Th.U. furnished by superheater	140·30	10·8
B.Th.U. furnished by boiler	1025·93	78·9
B.Th.U. furnished by feed heater	133·92	10·3

Boiler Efficiencies, including that of the superheater and feed heater, averaged 80·5 per cent., calculating on the total heat in the steam above 32 deg. and on the basis of the total heat above the mean cold feed temperature, the combined efficiency of the steam plant is $\frac{1372 \cdot 1 \times 5266}{44{,}091 \times 1300 \cdot 15} \times 100 = 75 \cdot 5$ per cent.

The Engines.

The mean pressure at the steam chest was 205 lb. and the superheat was on the average 209 deg. Fah. The heat content in the steam as furnished to the cylinders was therefore 1317 B.Th.U. On this basis the following cylinder efficiencies were obtained:—

	Lb.	Efficiency, p.c.
Steam rate per D.B.H.P. per hour	29·72	6·5
Steam rate per D.B.H.P. per hour	26·21	7·37
Steam rate per I.H.P. per hour	22·92	8·45
Steam rate per I.H.P. per hour	20·16	9·56

The higher steam figures include the steam consumed by the auxiliary equipment. The pressure at the steam chests was 91 per cent. of that at the dome.

The Locomotive Efficiency.—The overall efficiency of the locomotive is measured by the heat consumption per unit of power at the draw-bar compared with the heat content of the fuel fired. The losses in the transfer of the heat value in the fuel to the work on the draw-bar are the boiler, cylinder, and mechanical losses, the latter include machine friction, and for road tests such as the present, track and its related resistance, which include those due to gradients. Throughout the tests this locomotive was working almost entirely over rising gradients averaging, say, 1 per cent., and the locomotive efficiencies varied from a minimum of 4·67 at 13·25 m.p.h. to 5·99 at 17·62 m.p.h. The average locomotive efficiency is 5·22 per cent. and the machine efficiency—that is, the power developed at the draw-bar at the back of the tender divided by the I.H.P.—was 80·2 per cent. The power absorbed by moving the engine and tender over the road at 16·16 m.p.h. was 1923·7 − 1481·4, or 442·3 horse-power, representing a resistance of 10,263 lb. The total resistance due to gradient is for the locomotive in full working order 6590 lb., representing 284 horse-power.

From this it will be evident that had the locomotive been running on a level road, other factors such as curvatures being similar, and at 16·16 m.p.h. and under the same boiler and engine conditions, then the draw-bar horse-power developed would have been for the same fuel rate increased by 284, or to a total of 1765, or, say, 9 per cent., and consequently the locomotive efficiency would have been 5·67 per cent., owing entirely to the machine efficiency of the engine and tender being increased from 80·2 to 87·5 per cent.

Most of the data given have been supplied by Mr. W. E. Woodard, of the Lima Locomotive Works, and the writer is, in addition, much indebted to the *Railway Mechanical Engineer* for permission to reproduce the diagrams illustrating this article.

Incorporated Municipal Electrical Association.

No. II.*

WHEN the conference was renewed on Wednesday, June 1st, the whole of the morning was devoted to an important paper by Mr. T. Roles, City Electrical Engineer at Bradford, entitled "Recent Developments in Power Plant Design and their Effects on the Economy of Generation." This paper dealt principally with the use of increased steam pressures and gave a concise history of development in this direction, particular stress being laid upon what has been taking place in America, where the Edison Electric Illuminating Company, of Boston, has at the Edgar Station at Weymouth a plant operating at 1200 lb. per square inch, whilst a few months ago the Lakeside station of the Milwaukee Electric Railway and Light Company put into operation a plant having a capacity double that of the plant at the Edgar station, working at a pressure of 1400 lb. per square inch.

Mr. Roles explained that, last year, he had visited a number of the largest and most efficient steam-operated generating stations in the United States, and in addition to inspecting the two stations mentioned above, went over the Crawford-avenue station of the Commonwealth Edison Company of Chicago, the Philo station of the Ohio Power Company, and the Columbia station at Miami Fort of the Columbia Power Company, and saw there high steam pressure plants under working conditions. Incidentally he commented upon the fact that, apart from what might be regarded as experimental plants, the first definite step in the direction of higher steam pressures was made some ten years ago by the Newcastle-upon-Tyne Electric Supply Company, which decided to adopt a working pressure of 475 lb. per square inch at the North Tees station near Middlesbrough. This plant was put into service in 1920 and still claimed to be working under the highest conditions of steam pressure of any station in the British Isles. Since then, a number of power stations designed for working at pressures of 300 lb. per square inch and above, had been erected in this country, including the Barton station of the Manchester Corporation, the Barking station of the County of London Electric Supply Company, and the Agecroft station of the Salford Corporation. Nevertheless, the lead so boldly given by British engineers in this matter had been lost and American practice in particular had gone ahead much more rapidly. With regard to the Continent, although extra high steam pressures were in use in connection with a number of industrial plants, comparatively little progress had been made in that direction in

* No. I. appeared June 3rd.

power stations. The outstanding example of a continental power station working at high steam pressures was the Langerbrugge station of the Centrales Electriques des Flandres near Ghent, where since 1925 a plant had been in operation at a working pressure of 800 lb. per square inch and a total steam temperature of 840 deg. Fah., that being the highest steam temperature at which any power station plant in the world was normally operated. At Amsterdam a plant had recently been erected to work at a pressure of 600 lb. per square inch, and the very large Rummelsburg power station of the Berliner Elektrizitatswerke was operating at a pressure of 462 lb. per square inch. In referring to these more or less historical details, Mr. Roles did not overlook the work of the English Electric Company, Ltd., in connection with the Benson plant at its Willans Works, Rugby, with which experiments were made with steam at a pressure of about 3200 lb. per square inch, which was known as the critical pressure at which the densities of water and steam were equal and the water passed into steam without ebullition. That plant, put down for strictly experimental purposes, was a small one, but some very useful data were obtained, although unfortunately they had not been published. Comment was made upon the fact that although American engineers had gone well ahead in the utilisation of higher steam pressures, they had not for the most part adopted higher total steam temperatures than were employed in this country. Generally speaking, the steam temperatures in use in modern American stations were from 700 to 750 deg. Fah., although in very few instances had a temperature as high as the latter figure been adopted.

The paper had relation to modern generating stations in which steam turbo-generators and water-tube boilers were employed, and indicated the chief developments during recent years under the following heads :—

In the Turbine Room—
Higher steam pressures and temperatures.
Higher rotational speeds for large turbines.
Steam extraction from turbines for feed heating purposes.
Reheated steam.
Improvement in the design of condensers.

In the Boiler-house—
Higher steam pressures and temperatures.
Increased capacity of boiler units.
Reheater boilers.
Water-cooled furnace walls.
Air preheaters.
Regenerative feed heating.
Pulverised fuel firing.
Improved types of stokers.
Automatic combustion control.

The information contained in the paper was collected in connection with the author's investigations prior to determining the type of plant to be adopted for extensions at the Valley-road power station of the Bradford Corporation, where eventually it was decided to adopt plant of a pioneer nature so far as this country is concerned. This new plant was, it was explained, to work in conjunction with the existing normal pressure turbines, and although it was only of 2500 kW capacity—the maximum continuous rating—it was sufficient to deal with the base load of the station, the remaining load of poor load factor being dealt with by normal pressure and, therefore, cheaper plant. The steam from the high-pressure plant would be exhausted intothe normal-pressure steam range and utilised in the normal pressure turbines coupled to that range.

The author went on to say that the boiler, which would be of the cross-drum marine type, would have normal and maximum evaporative capacities of 75,000 lb. and 94,000 lb. per hour respectively, and would be constructed for a working pressure of 1100 lb. per square inch gauge. The steam would be superheated to a total temperature of 800 deg. Fah. by a superheater fitted interdeck above the first rows of tubes. The boiler would be fired by compartment-type chain grate stokers. The gases on leaving the boiler would pass through a steel tube economiser and an air preheater, the latter of which would raise the temperature of the air passing to the chain grates to about 250 deg. Fah. The furnace would have water-cooled walls and would be so constructed that pulverised fuel firing could be employed at a later date, if considered advantageous. No reheater was at present being incorporated with the boiler, but the latter was being so designed that a reheater could be added, should experience prove that to be desirable. The high-pressure turbine would be of the single-cylinder impulse type, designed to run at a speed of 6000 revolutions per minute, and to drive, through the medium of double helical reduction gearing, an alternator of 2500 kilowatts capacity—maximum continuous rating—running at a speed of 1000 revolutions per minute. The turbine would exhaust steam at a pressure of about 210 lb. per square inch and at a temperature of about 510 deg. Fah. into the main steam range of the station.

The feed water, on leaving the condenser of the normal pressure plant, would be heated in several stages on its way to the high-pressure boiler by steam "bled" from both the high and the normal pressure turbines. The turbine had been designed to work at a pressure of 850 lb. per square inch.

Mr. Roles expressed the opinion that, generally speaking, it would probably be found advantageous that stations which were in future put down to deal with the base loads of large systems should be equipped with high-pressure plant throughout, and that the working pressure for such stations should be from 500 lb. to 700 lb. per square inch. In cases, however, in which the station load factor was to be dependent upon the load factor of the system or in which high pressure was introduced for the purpose of increasing the economy of an existing normal pressure station the high-pressure plant installed should be designed to work at pressures approximating to 1000 lb. per square inch. The view was also expressed that whilst capital charges and cost of repairs and maintenance might be anticipated to be somewhat higher in the case of a high-pressure plant than in the case of normal pressure plant, the extent to which they were higher would not prevent a considerable overall saving being effected by the utilisation of high-pressure steam plant, when it could be run at suitable load factors. Further, the higher the price of fuel the greater were the monetary savings which could be effected, and, assuming each type of plant to be run under equal conditions as regarded vacuum, the lower the vacuum the greater was the saving attendant upon the use of high-pressure plant.

In conclusion, the author expressed the view that it was now impossible to design a power station to work at the highest efficiency unless the functions of the turbines and auxiliaries were properly co-related to those of the boilers and auxiliaries. Until comparatively recently, the only connection between the turbine-room and the boiler house had been the main steam pipe and the condensate return pipe, the latter usually being a connection of a very loose nature. With the introduction of regenerative feed heating, however, the relationship between the two became far more intimate, and, if reheating of the steam was carried out, it became still closer. That factor would in future cause responsible engineers considerable difficulty when dealing with contracts for the installation of new plant, as the correct proportions and functions of one item of plant were now so interdependent on those of others.

Mr. I. V. Robinson, of the British Electrical and Allied Manufacturers' Association, in opening the discussion, urged that total economy should be considered more closely in relation to the use of higher steam pressures. That took into account the capital cost of high and normal pressure plant, and although high-pressure plant at the moment was higher in capital cost than normal pressure plant, present figures were not a fair indication of what the position would be when high-pressure plant was more commonly used. The scheme adopted at Bradford of using a high-pressure turbine exhausting into normal pressure steam mains was only a temporary expedient, and ultimately the common practice would be to have a small high-pressure cylinder working in tandem with a normal pressure cylinder. Although the Bradford scheme was right now, it would not survive, if only for the reason that it was more expensive. In striving after the last ounce of steam consumption and the last fraction of percentage in thermo-dynamic efficiency, he did not think station engineers were following the wisest course, although he felt that they had been led in that direction by the publication of the tables of thermal efficiency of power stations issued by the Electricity Commissioners. Such publication was not, he thought, in the best interests of the industry, and instead of striving after efficiencies of 83 or 85 per cent., it would be better to concentrate upon a simpler machine, a single-cylinder machine, for very much larger outputs than at present, to keep it in tip-top condition, and be content with an efficiency of 80 per cent. If thermal efficiency was to be the only aim, then internal combustion engines would have to be resorted to. The Electricity Commissioners should, at all events, adopt some other method of comparison of power station efficiency, such as grading them on the cost per unit according to the nature of the load. It was not fair to compare a station with a purely lighting load with one having a large percentage of industrial supply. As to reheating steam, from what he had seen and heard, there appeared to be a lot to do before that would be a practical success.

Mr. R. A. Chattock—City Electrical Engineer of Birmingham—said that many of the ideas that had guided Mr. Roles in his decision had also guided him in designing his new power station at Birmingham. He was aiming at an overall efficiency of 23 per cent., and he believed that he would easily get it, even with cooling towers. The boilers would each have an evaporative capacity of 200,000 lb. of water per hour, whilst four new boilers, being installed at the existing Nechells power station at Birmingham, would each have an evaporative capacity of 180,000 lb. per hour. By the use of pulverised fuel, it was possible to use boilers of that size more efficiently, and although he was not fitting automatic control at first, the boiler plant would be designed so that it could be added later. This new station would have a steady base load to handle, and therefore automatic boiler plant control was not so necessary as if the load was a fluctuating one. He was using the Bailey meter as an indicator only to maintain correct air and fuel mixture in the furnaces, and in that way it would be possible for one man to control the whole of the boilers in the station as long as they were working on a steady load. His experience with pulverised fuel had been that it was better to use water-cooled walls than air-cooled walls for the furnaces, because in that way it was possible to get the CO_2 to a higher figure. With air-cooled walls in his existing boilers, the CO_2 was 14 per cent., but using Murray fin tubes he hoped to be able to reach 16 per cent. He also held the view that the unit system of pulverised fuel was far less costly to install and maintain than the central pulverised fuel arrangement. For his 200,000 lb. per hour boilers he would have five unit pulverisers, four of which would be sufficient to give the full output, the remaining one being spare. Finally, Mr. Chattock said that he had placed the order for the whole of the new power station with one firm, which would be responsible for the overall efficiency.

Mr. Chittenden, of the English Electric Company, gave some account of the experimental work carried out on the Benson plant, using a steam pressure of 3250 lb. per square inch, for which his company made the turbine. The plant had a capacity of 300 kW, and worked continuously for two years without giving any trouble, and it could have taken its place in a power station on a commercial load. Efficiencies of over 80 per cent. were obtained with that boiler without preheating, or other additional operations, and other figures of efficiencies obtained with boilers using 500 lb. per square inch showed that those high-pressure boilers could be made to give efficiencies within 2 or 3 per cent. of those of normal pressure plant. In the Benson boiler the steam was generated at 3250 lb. and used at 1500 lb., and was superheated to a total temperature of 800 deg. Fah. The Benson boiler consisted of a coil of tubes without side headers placed in a casing lined with fire-brick. The products of combustion went up through a central tube, down through the superheater and through the boiler itself and out at the bottom, thus giving contra-flow as far as the heat to the water was concerned. A reciprocating pump was used for supplying the water, and for those higher pressures that type of pump would have to be considered, although it had one great disadvantage, viz., the question of control. Two points that were brought prominently to notice as regarded the turbine in those extra high-pressure experiments, were the volume of steam at the high-pressure end and the wetness in the steam at the low-pressure end, and in his opinion it was essential in such circumstances to use one or more additional cylinders because, with very short blade heights and short nozzles, a single cylinder was detrimental to the efficiency. Moreover, with a multi-cylinder turbine the sting was taken out of the steam in a small and compact unit, and as far as he had seen, machines of that type could be handled much more rapidly and could be put on load much more quickly, and, moreover, were not subject to distortion troubles.

Mr. J. H. Bowden, the Borough Electrical Engineer, Poplar, said that he had recently inspected the Benson boiler at the works of the Siemens-Schuckert Company, which, he said, was much bigger than the boiler referred to by Mr. Chittenden, and was not in the experimental stage. It was to be used in the ordinary way. The boiler was octagonal in shape, and was 44ft. high by 12ft. to 13ft. in diameter. It was designed to work at 225 atmospheres, or, say, 3250 lb. per square inch, and the turbine was arranged to work with a pressure of 180 atmospheres. In the centre of the boiler was a circle of tubes, roughly 22ft. in length, and the steam was brought back from the turbine into the reheating tubes which were situated behind the main tubes in four of the sections of the octagon. In the other four sections were situated the superheater tubes and the air heater tubes. It was anticipated that that high-pressure plant would cost about 8 per cent. more than normal pressure plant in capital cost, but it was expected to get an increase of 14 or 15 per cent. in thermal efficiency. Two pumps were used, one of the rotary type running at 6000 r.p.m., with twenty-two stages, and the other of the rotary type running at 180 r.p.m., with six plungers. The remarkable features of the boiler was that there were no steam drums, and no brickwork, and that the total water in the boiler at any one time was only 800 lb., or 80 gallons. The boiler was fitted with three pulverisers, so arranged that they set up a cyclonic action in the burners.

Mr. W. Bayliss, of Messrs. Babcock and Wilcox, Ltd., referring to the higher cost of high-pressure steam plant, said that manufacturers were not in business for their health, but that they were fair-minded people and were willing to bear a fair share of the extra cost involved in developing the new designs. He anticipated a rapid increase in the use of these plants when engineers were convinced that the troubles they anticipated had been dealt with, and then the capital cost would fall rapidly. Speaking generally, he said that manufacturers of the plants were ahead of or right up to the metallurgists, and as soon as metallurgists produced materials which would safely withstand higher temperatures than those mentioned in the paper, the makers were prepared to go forward. On the question of the use of pulverised fuel, Mr. Bayliss said that it was common knowledge that beyond a certain capacity, stoker-fired boilers were not the best possible proposition, but capital charges played a very important part in determining the type to be used. Improvements were being made every day, both in stokers and pulverised fuel arrangements, but at the moment there were no pulverised fuel stations operating in

this country with as high an efficiency as could be obtained with stoker-fired plants.

Mr. A. Q. Carnegie, of C. A. Parsons and Co., Ltd., spoke on the question of reheating, said that it had been tried in several stations in this country, but that it had never been tried whole-heartedly. Recently, however, his firm had been associated with the supply of a 50,000-kW machine for Chicago, and it aimed at a temperature of 750 deg. Fah. for the reheat. Some calculations he had made showed that with a steam pressure of 750 lb. per square inch a saving of 6·8 per cent. could be obtained, as compared with a pressure of 350 lb.; but the very same saving could be obtained by reheating with a pressure of only 400 lb. per square inch. That demonstrated the advantage of reheating, which should not be turned down lightly. He had discussed that question with engineers in the United States who were working with reheating, and they all expressed their satisfaction with it. He agreed with Mr. Bayliss that all first-class engineering firms were willing to bear their fair share of the cost of introducing new plant, but that it was only natural that prices would be higher for the first plants sent out. All firms could not take up the manufacture of these high-pressure steam plants or they would fail commercially. Speaking of the work of the Nozzle Research Committee, Mr. Carnegie contended that in the whole of those researches they had not found a nozzle which was more efficient as a nozzle than the Parsons reaction blade that was introduced and standardised twenty-five years ago.

Mr. David Wilson said that, whilst at one time he had strongly defended the mechanical stoker as against pulverised fuel—and he still did so within its useful sphere—the fact that three million kilowatts of powdered fuel plant were in operation must compel us to have regard for pulverised fuel. The whole question, however, was one of capital cost. Unfortunately, up to the present the capital cost of pulverised fuel plant had been higher than that of stoker plant; but capital costs were rapidly falling, and for an installation including boilers capable of evaporating 300,000 lb. of steam per hour, the pulverised fuel plant worked out at 10 per cent. less capital cost than stoker plant. After the enthusiasm shown by Mr. Roles for pulverised fuel, it would have been thought that he would have adopted pulverised fuel. As a matter of fact, the reason was not that the capital cost of the pulverised fuel plant was prohibitive, but because the total cost of the scheme had exceeded the estimates. Whilst the capital cost of powdered fuel plant would have been 10 per cent. more than stoker plant, the capital cost of the particular boiler adopted was ten times the cost of a normal pressure plant. Therefore, on his own logic, Mr. Roles ought to have condemned the high-pressure boiler and put in a standard plant with powdered fuel firing. Undoubtedly, continued Mr. Wilson, the time was coming when the rating of boilers would be very much higher than at present, and, with side wall cooling, there was no reason why we should not get up to 12 lb. or 15 lb. per square foot of heating surface. The Manchester boiler was the first attempt in this country to design a boiler for powdered fuel, and it was the first unit which had a 100 per cent. steel furnace. It had been operating for two years without any trouble as regarded the ignition of the powdered fuel and in maintaining combustion. That was due to the adoption of a large air heater. Mr. Wilson claimed that it is possible to-day to produce a cheaper unit for the use of powdered fuel as compared with a stoker fired unit by using a steel furnace with a large air heater and a large economiser to recover the waste heat.

Dr. S. Z. De Ferranti spoke of the early attempts in this country to use higher steam pressures and of the difficulties encountered by manufacturers in developing new plants of that description owing to the cost involved, the small margin of profit generally precluding them from going ahead as fast as would otherwise have been possible. He commented on the slow progress made in steam generation plant during a period when rapid development went on in electrical plant. It was also recalled that in 1910 experiments were carried out at the River Don Works of Vickers Ltd. with a 3000-kW plant in which there were regenerative feed heating and a high degree of superheat as well as air heating. That plant worked quite successfully, but was eventually abandoned for reasons other than anything connected with the main principles. Had it been possible to continue the experiment it would have pushed the industry along many years, but it was not till some years later that the reason was found for a very serious steam leakage past the bulk of the blades of the turbine which accounted for the steam consumption, excellent though it was, not being as good as had been anticipated. Re-superheating by means of high-pressure high-temperature steam, which was part of that experiment, was mentioned in one of his patents, but he had never actually put it into practice because he had not been able to see how to make it really good engineering. He agreed with Mr. Carnegie, however, that it could not be lightly put on one side. On the general question of cost of generation, Dr. Ferranti said that he had been told in conversation with some of the leading supply station engineers in America, that if they could generate for nothing, it would not be possible to supply electricity very cheaply because of the cost of distribution. He also added the fact that at the East River station of the New York Edison Company, which was the latest station on the other side of the Atlantic, and in which two 60,000 kW single-cylinder turbines had been put to work, and all the conditions were favourable in the way of a long hour load and a wonderful load factor, they had not adopted re-superheating, but they had adopted regenerative feed heating. At the same time, they had adopted a boiler pressure of only 375 lb., and that had so surprised him that he had written to America for an explanation.

Major Heenan, after referring steam engineers to the oil-refining industry for information as to the successful handling of high pressures and temperatures, said that the capital cost of steam generating plant could be kept down by increasing the gas velocities through the boiler, superheater, economiser and air heater, with a consequent cutting down of the heating surface. The rate of heat transmission went up as the velocity or mass flow increased, and therefore more powerful fans would be required. Thus it was a question of balancing the cost of the extra fan horse-power against the reduced capital cost of the plant through increasing the gas velocities.

Mr. R. B. Mitchell—City Electrical Engineer of Glasgow—asked whether the difficulties associated with the emission of very fine dust from the chimneys when using pulverised fuel had been overcome, because that was a serious objection from the point of view of a power station situated in a densely populated area. Incidentally, he suggested the possibility of a combination of stoker-fired plant and pulverised fuel plant, so that the pulverised fuel plant could carry the peak load and the stoker-fired plant could carry the base load.

Mr. Potter, of Simon-Carves, Ltd., said that experience had shown no deleterious effects from the very fine dust emitted from pulverised fuel plants. The dust was much finer and more completely burned than that from stoker-fired plants, and therefore less noxious. Grit catchers were being fitted for pulverised fuel plants, but they were also being fitted for stoker-fired plants. On the question of the use of bare or covered tubes for cooling the furnace walls, he regretted that more had not been said about that matter. Mr. Roles had adopted tubes covered with refractory material, and it occurred to him that bare tubes might be liable to give more trouble with pulverised fuel when working on a varying load.

Mr. Roles, in a brief reply, expressed his regret that the discussion had not been more critical of his proposals, because he had been hoping to obtain some information which would enable him to make his plant more efficient. On the general question of pioneer work of that description, he paid a tribute to the broad-mindedness of the Bradford Electricity Committee, which had given him a free hand. The question of pioneering new developments would have to be given serious consideration by the I.M.E.A. When he was in America he formed the opinion that the electrical industry had developed rather faster there than we have in Great Britain, probably because the bulk of the business was in the hands of companies. That might be a serious statement to make to an association of municipal electrical engineers, but he made it with a full sense of responsibility. The municipalities in Great Britain had the greater part of the industry in their hands, and if they were not going to develop it, then not only would they be doing badly for themselves and their consumers, but they would not be helping the British electrical and engineering industries to keep the place in the world they should have. Therefore the individual members of the I.M.E.A., and the I.M.E.A. as an organisation, would have to take that matter carefully into consideration.

ELECTRIFIED HOMES.

On Thursday, June 2nd, a paper, entitled "Electrified Homes of Great Britain and Ireland, with special reference to the Heating Question," was read by Mr. H. H. Berry. The members of the Electrical Association for Women were specially invited to take part in the discussion, and an unusually large number of ladies spoke in the discussion. The paper advocated a combination of the coke boiler for heating houses, in conjunction with the aid of electricity for local heating, cooking, lighting, &c., and for the want of a better title the author referred to the scheme as the "Colectric" system. On the whole, it cannot be said that it received very much favour, being regarded as too much of a compromise and a makeshift, whereas the general view was that we should adopt the all-electric system and have done with it. There were, however, some supporters of it.

At the dinner in the evening the principal speech was made by Sir Harry Haward, one of the Electricity Commissioners, who assured the electricity supply authorities of the country that the Commissioners endeavoured to base their decisions impartially upon the technical facts placed before them. In expressing the belief that the owners of "selected" stations would co-operate with the Central Electricity Board and the Commissioners in every possible way, he made a special appeal to the smaller supply authorities to throw themselves whole-heartedly into the scheme contemplated by the Electricity Act of 1926, and hinted that as time went on experience would show that still further legislation might be necessary.

The annual general meeting of the Association was held on Friday, June 3rd, but was private. The President for the coming year is Mr. F. W. Purse, Engineer and Manager of the West Ham electricity undertaking.

Mechanical Vibration Filters.

IN a series of articles on "Models and Analogies for Demonstrating Electrical Principles," published in THE ENGINEER last year, we described various mechanical devices that have been devised for the purpose of teaching electrical engineering. Since those articles appeared an ingenious mechanical filter has been brought to our notice by Mr. V. L. Hartley, a member of the technical staff of the Bell Telephone Laboratories, and the following is a description of this filter, written by Mr. Hartley for the *Bell Laboratories Record*, the official publication of those laboratories. Unlike most of the models previously described, this mechanical filter has not merely been designed for educational purposes, for it may replace an electrical filter in the electrical part of a communication system.

Communication requires for its accomplishment changes, variations, or alternations in the condition at the transmitter and the transmission of the effects of these changes to the receiver. It is the change and not the steady condition which permits the transmission of speech or signals, and it is the alternating components of the effect in the sender which must be transmitted to the receiver and there interpreted or translated. In electrical systems of communication the effects at the transmitter are complex alternating currents with components of a wide range of frequencies. The cause of the current is, of course, a corresponding complex motion of some part of the transmitter, the diaphragm for example, in the case of a telephone. In this case the motion is imparted to the diaphragm by the complex sound wave which has been transmitted to the sending apparatus through the homogeneous mechanical medium of air. In other cases a complex vibration, for example, of the needle in reproduction from a phonograph record, is transmitted mechanically to the sending device, which converts the mechanical vibration into electric currents. In general, then, an electrical system of communication involves at its end mechanical devices for the transmission of vibrations and between them an electrical channel for the transmission of alternating currents of corresponding frequencies.

Selective transmission of vibrations, whether electrical or mechanical, is a necessity of present-day communication systems. Moreover, it often happens to be desirable to transmit only vibrations with frequencies which lie in a definite range, and to transmit these equally well—in other words, to transmit a band of frequencies. This requirement was met first for electrical oscillations by the development of so-called "electrical filters," and more recently for mechanical oscillations by analogous devices called "mechanical filters," in which the selection, according to frequency, is performed by mechanical parts. The operation of mechanical filters may be understood by comparison with electrical filters and by the employment of certain electro-mechanical analogies. In an electric circuit an alternating electromotive force, acting to set up a current, is accompanied by a reaction in the form of a counter-electromotive force. The relation of this counter-electromotive force to the current, as regards amplitude and phase, depends on the nature of the circuit; but whatever the relation, the current takes such a value as to make the counter-electromotive force equal and opposite to the driving electromotive force. For any particular circuit the ratio of the counter-electromotive force to the current is characteristic. The ratio, which is called the impedance of the circuit, is not only a magnitude but also involves a phase value that expresses the portion of a cycle by which the alternating effect lags or leads the alternating cause. It is therefore a vector ratio.

If the circuit is such that the energy supplied to it is all dissipated immediately, or all transmitted on, then the electromotive force is in phase with the current, and the impedance is a real quantity, which is called a resistance. If, however, the circuit contains a coil or a condenser, since both are capable of storing energy and subsequently returning it, there is introduced in the counter-electromotive force relative to the current a phase lead or lag. The flow of energy is not all in one direction, but undergoes reversals in direction. The impedance is then a complex quantity, of which the real part is called the resistance and the imaginary part the reactance. Analogous to this electrical system is a mechanical system which is maintained in forced oscillation by an alternating driving force. Corresponding to the current and to the counter-electromotive force are respectively the velocity of the driven point and the accompanying counter force. By analogy the vector ratio of the

counter force to the velocity is called the mechanical impedance of the system.

The mechanical impedance, like the electrical impedance, depends upon whether the system involves elements capable of storing energy. If such is not the case—if, in other words, the storage of energy is negligible compared with its dissipation—then the velocity is in phase with the driving force and the impedance is a "mechanical resistance." Friction and dissipational effects, in general, introduce resistance; mass and elasticity introduce reactance. When mass is set in motion the counter force is proportional to the rate of change in velocity; the force leads the velocity in phase; and the mechanical reactance is positive. Mass is thus analogous to inductance where the counter electromotive force is proportional to the rate of change of current. Where elasticity enters, on the other hand, a restoring force comes into action, which is proportional to the displacement, that is, to the integral of the velocity. This is similar to the action in a condenser where the force is an electromotive force proportional to the quantity of electricity, that is, to the integral of the current. The restoring force lags in one case behind the current—that is, the velocity of moving electricity—and in the other behind the velocity of

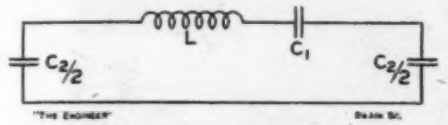


FIG. 1—DIAGRAM OF ELECTRICAL FILTER

mechanical motion. Corresponding, therefore, to the capacity of a condenser is the so-called "compliance" of an elastic system, which is the reciprocal of its stiffness.

Since the three elements of an electrical impedance, namely, resistance, positive reactance and negative reactance, have analogies in mechanical impedance of dissipation, mass, and compliance, a mechanical analogy of an electrical filter may be produced by selecting a mechanical element analogous to each element of the electrical filter and combining the elements in such a way that their interactions involve principles analogous to those of the electrical network.

The electrical filter of Fig. 1, a common type, has for analogy the mechanical filter of Fig. 2. The latter is an early experimental model in which the driving force is set up electrically by one of the moving armature structures which terminate the filter. A connecting-rod imparts to the reeds a vibratory motion in the direction of the driving rod. These

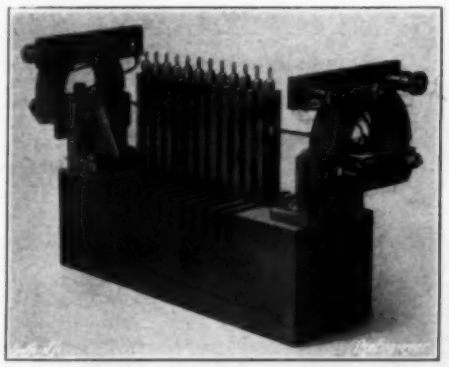


FIG. 2—HARTLEY EXPERIMENTAL MECHANICAL FILTER

reeds, and the spiral springs with which they are connected, constitute the reactive elements of the filter. At the distant end the terminating mechanical impedance is supplied by the other electro-magnetic element, which converts into electrical energy the mechanical energy delivered to it from the filter. If this electrical energy is dissipated in an electrical resistance or transmitted away by a line, the mechanical impedance, which is thus presented to the filter through the connecting-rod, will be approximately a pure resistance for the frequencies which are transmitted by the filter.

The action of this mechanical filter is analogous to that of the electrical filter, to the ends of which are connected electrical circuits or devices which offer impedances of essentially pure resistance and of proper value. The proper terminating impedances are essential to securing the desired band selectivity of frequencies. Their quality of resistance can be, and, of course, often is, obtained in the form of an effective resistance as when an electrical filter is connected to a long uniform line which transmits energy on as fast as it arrives. The analogies between electrical and mechanical elements of reactance lead to corresponding analogies as to the interactions which occur in the sections of the electrical and mechanical filters. Whereas in the electrical circuit there is an alternating current, in the mechanical circuit there is a sinusoidal velocity. Similar to the current in the series branch $L C_1$, of an electrical section, is the velocity of the reed in the mechanical section at its point of connection with the spiral spring. Its mass and compliance, due to its inertia and its stiffness, correspond to inductance and capacity.

In the electrical case the current in any one series branch divides between the next series branch and the intermediate shunt; and the current to the shunt is the algebraic difference, between the currents in the two adjacent series branches. Similarly, any difference between the velocities of two adjacent reeds must equal the velocity with which the ends of the connecting spring approach or separate. The spring, in other words, serves in its compliance in a manner similar to the shunt condensers of the electrical circuit. Its variation in length is accompanied by a counter-force which lags behind the velocity and tends to move the adjacent reeds in opposite directions. In this action the counter force is similar to the lagging electromotive force across the shunt condenser of the electrical section, which tends to send currents in opposite directions through the adjacent series branches.

A mechanical filter, therefore, performs in the transmission of mechanical vibration functions similar to an electrical filter for electrical vibrations. It is subject to similar requirements as to the relations of its terminal impedances. A mechanical filter may form a part of the mechanical system in which an electrical communication system terminates or if it is provided with electro-mechanical apparatus at its terminals, as was done in the experimental model of Fig. 2, it may replace an electrical filter in the electrical part of the system.

For the electrical filter of Fig. 1 the band of frequencies which is passed lies between a lower limit which is set by the resonance frequency of the series branch (L and C_1) and an upper limit, which is set by the resonance frequency of a section of the filter taken as a whole—that is, of L in series with C_1 and the two capacities $C_2/2$. The impedance of the filter, as computed across the terminals to which the source is connected, is practically a pure reactance, independent of the number of sections involved, for all frequencies outside these limits. The counter electromotive force and the current are a quarter of a cycle out of phase. The current, therefore, is "wattless," as the electrical engineers would say; and energy surges into the filter and out again in equal amount, twice for each cycle of the driving force. These periodic oscillations of energy are greatest between the source and the first section of the filter. Progressively, less disturbance extends to the following sections, and practically none reaches the terminating impedance. That is why these frequencies are said to be suppressed by the filter. For frequencies within the transmitted band the impedance of the filter, when terminated by the proper resistance, is also a resistance and of the same value as the terminating resistance, and this is the case without regard to the number of sections in the filter. This means that the flow of energy of these frequencies is continuously in one direction—and not alternately in and out as for frequencies beyond the band limits. Within each section there is negligible resistance, and hence negligible dissipation of energy; so that current flows into the terminating resistance precisely as if this resistance were connected directly to the source.

THE "IRON BRIDGE" AT PLYMOUTH.

ONE of the first iron bridges of its kind to be built in England celebrates its centenary next month. It is the "Iron Bridge"—as it is popularly known—which spans the river Plym at Laira, on the eastern side of Plymouth. The young architect who planned the bridge, Mr. James M. Rendal, was a man of original ideas, and one of the first to foresee the possibility of using iron instead of stone in such structures. The work of construction was begun on August 4th, 1824, and on March 16th of the following year the foundation stone was laid by the then Lord Morley, Lord of the Manor. On July 14th, 1827, the Duchess of Clarence, afterwards Queen Adelaide, opened the bridge and was the first to pass over it. For a century the structure has been a boon and a blessing to the locality, and its strength and utility are said still to be unimpaired, notwithstanding the heavy burden of the ceaseless motor traffic of to-day. The bridge, which is 500ft. in length, is composed of five elliptical arches, the centre one having a span of 100ft., the two next 93ft., and the two outer arches 81ft. The roadway is 24ft. wide, and is 22ft. above high-water mark of spring tides. Like most bridges built many years ago, there was a toll bar at one end of it, but the tolls were redeemed and the toll house abolished by the Plymouth Corporation a couple of years ago. The question of bridging the river Tamar and providing another link between Devon and Cornwall was an urgent matter even in Rendal's time, and he was a strong advocate of the idea of throwing an iron bridge across that river also, a suggestion in which he received great encouragement from the Lord Morley of his day. The bridging of the Tamar is still a topic of discussion, but the fulfilment of any such scheme seems to be almost as far off as ever.

MANCHESTER ELECTRICITY SUPPLY.

IN its annual report to the City Council, the Electricity Committee states that the receipts for the year ended March 31st last amounted to £1,643,137, which, after deducting working expenditure, exclusive of depreciation, amounting to £984,106, left a balance of £659,031. Interest, sinking fund and income tax was £618,372, leaving a net surplus of £40,659, compared with £32,857 last year. The increase in the volume of business amounted to 7·7 per cent., the sales totalling 323·547 million kilowatt-hours. The average price of fuel increased owing to the national coal dispute by 152d. per ton, the consumption totalling 291,678 tons. The average weight of fuel consumed per kilowatt-hour of electricity sold fell from 2·09 lb. to 2·02 lb. No additional generating plant was installed at the City and Stuart-street stations, but at Dickinson-street station two 3000-kVA static transformers were replaced by two of double that capacity. The function of these transformers is to step down the pressure of the 33,000-volt supply transmitted from Barton to the standard high-tension feeder and sub-station pressure of 6600 volts. At the Barton station there were no additions to the generating plant, but substantial advancement was made with preparatory work for the extensions now in progress. The principal design work was completed and contracts were placed for general building, steel work, boiler plant, generating and condensing plant, and switchgear. The necessary excavations were made and foundations are in course of preparation for the main building framework. A tenth boiler for burning pulverised fuel is in course of erection. The normal thermal efficiency of the station was maintained. Confidence in the future of this station is demonstrated by the decision to install a 40,000-kW turbo-alternator. The efficiency of the distributing system as a whole equalled 85·59 per cent., the quantity absorbed in the mains and distributing stations being 14·41 per cent., showing an improvement of 0·83 per cent. compared with the preceding year.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

DEARTH OF USEFUL BRITISH INVENTIONS.

SIR,—With reference to the leading article in your issue of May 27th, regarding the lack of progress in useful invention in this country, as compared with some others, there are certain reasons that may be largely contributory to this state of affairs.

The protection afforded by letters patent granted to an engineer—as determined by case law—who is an employee in a position superior to that of a manual worker is to all intents and purposes nil. In the event of the patent or process improvement having the slightest bearing upon the class of work ordinarily dealt with by him, and even if the experimental work is carried out in his own time and with his own material, and, further, even if he holds an agreement with his employer entitling him to benefit by his invention, yet the employee has no protection.

He is open to summary dismissal by an unscrupulous employer upon a frivolous pretext, and the Courts have held, even in the face of the foregoing, that he can be compelled to assign all rights to his employer and receive only such out-of-pocket expenses as were incurred in securing his patent.

The manual worker, on the other hand, may use his master's material and perfect the invention in his master's time, and still be entitled to hold his patent. The difference between the protection afforded the different classes of employee may be due to the manual worker having a trade union, whereas there is no active body to protect the interests of the salaried employee. In many other countries such a condition of affairs has been remedied, and any employee is held to be entitled to some benefit for his devotion to scientific and industrial progress.

A knowledge of the unfair conditions imposed upon salaried employees in this country has undoubtedly often acted as a deterrent to repress any enthusiasm which may have been evinced in the earlier stages of many an engineer's career, and is one cause of the dearth of useful inventions, i.e., those which are known to be necessary by men intimately acquainted with the state of the art, as distinct from those inventions which are the product of those possessing only a superficial knowledge of the requirements.

ATHOL G. EVANS.

London, N. 12, June 4th.

THE LAST BEAM ENGINE.

SIR,—Among all the very numerous forms of steam engines which have been built, none has the historical association that the beam engine possesses. Introduced by Newcomen, and so vastly improved by Watt, the beam engine became the standard type, and such engines were constructed till comparatively recent times. It would be of interest, however, to ascertain when the last was constructed, and perhaps one of your readers can tell us. In answer to a question of mine, Messrs. Hick, Hargreaves and Co., of Bolton, tell me the last they built was constructed in 1884 for Messrs. J. and A. D. Grimond, Dundee. This engine was of the compound condensing type on McNaught's principle, with Corliss valves. The high-pressure cylinder was 34in. diameter by 3ft. 6in. stroke; the low-pressure cylinder, 42in. diameter by 7ft. stroke. It was designed to develop 700 I.H.P. when supplied with steam at 50 lb. pressure. There are, of course, hundreds of beam engines still running, but I imagine few built after the date of this one.

EDGAR C. SMITH, Engineer-Captain, R.N. (Ret.)

Science Museum, South Kensington,
June 2nd.

IT is thirty years ago to-day—which was also a Whit Friday—when one of the long-day excursions so popular in Lancashire at the end of Whit-week was wrecked at Welshampton on the then Cambrian Railway. The special was from Oldham to Aberystwyth, and was on its return journey. The vehicles were of Lancashire and Yorkshire bogie stock, but as it was necessary to provide a leading van the Cambrian furnished one which was considerably lighter than the other coaches. When near Welshampton the train was derailed and eleven passengers killed. On inspection it was found that the track was very imperfectly maintained, which factor, coupled with the oscillation created by a light van between the locomotive and heavier coaches, caused the van to leave the rails and the succeeding vehicles to follow.

THE STOURPORT ELECTRIC POWER STATION

MR. J. T. H. LEGGE, SMETHWICK, ENGINEER

(*For description see opposite page*)

FIG. 1—22,500 k.V.A. TURBO-GENERATORS

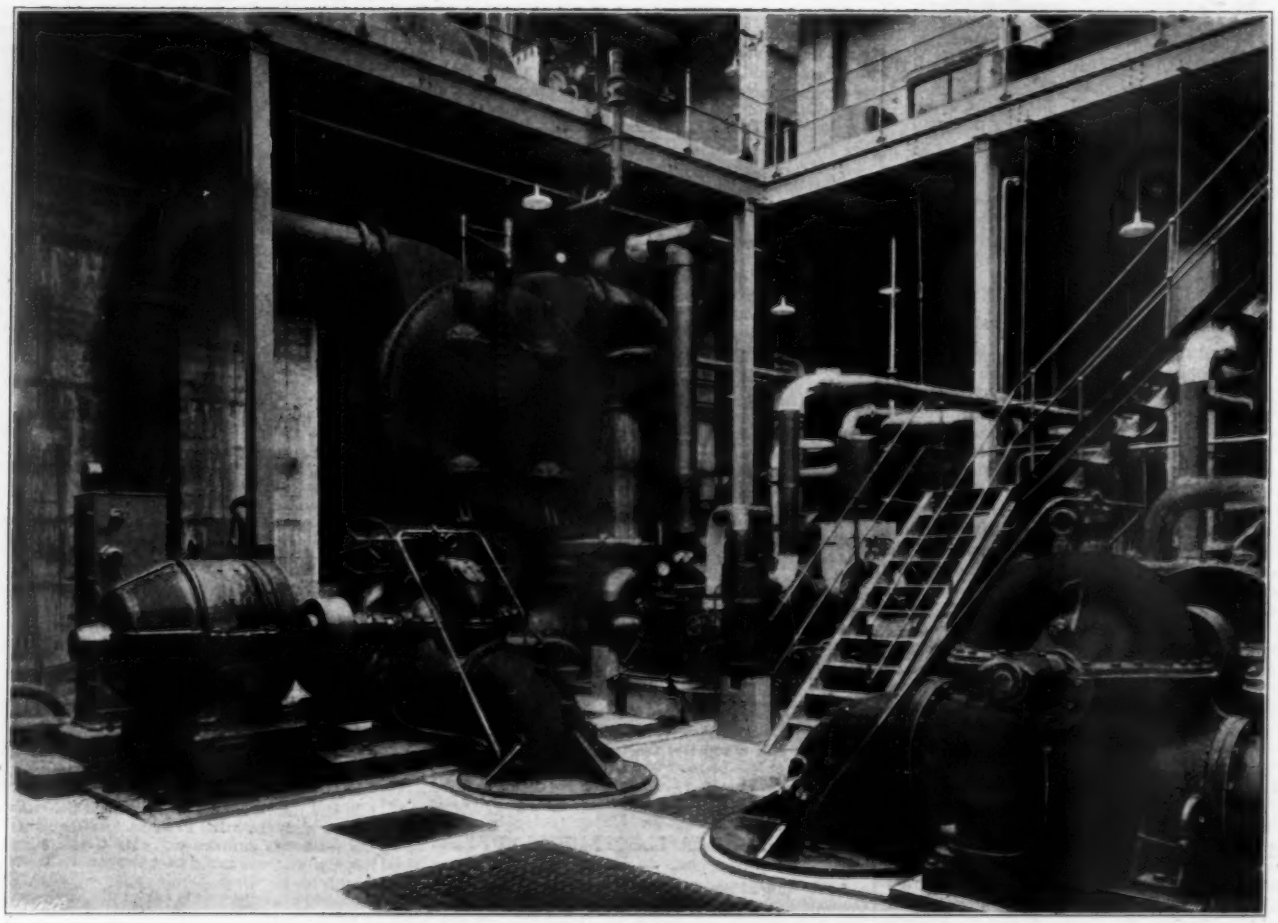


FIG. 2—CONDENSER PLANT AND AUXILIARIES

The Stourport Power Station.

No. I.

WHILE modern power stations are all designed on similar lines and do not reveal any revolutionary ideas, they differ considerably from those built in bygone days. Modern methods of dealing with coal and ashes have made it possible practically to eliminate dirt and dust, whilst the use of high-speed turbines has reduced noise. The unsightly buildings that were at one time erected to house the machinery have in some cases given place to structures of artistic design which harmonise with pleasant surroundings.

One of the finest stations recently put into operation in this country is undoubtedly the Stourport station of the Shropshire, Worcestershire and Staffordshire Electric Power Company, which was officially opened by the Prime Minister on Thursday, June 2nd. Situated at Stourport, Worcestershire, at the head of the navigation portion of the river Severn, at a distance of 60 miles from Sharpness Docks, the station—shown in Fig. 3—presents an exceptionally fine appearance, and the site meets all the requirements of a large electric generating plant. Sufficient water can be drawn from the river to satisfy the demands of a 250,000-kilowatt plant, whilst coal can be delivered to the site from various Midland coalfields *vid* the river, railway or canal, which joins the river near the power-house and has connections with various other waterways. For the erection of the Stourport station 32 acres of land were acquired on the eastern bank of the river immediately south of the confluence of the river Stour with the Severn, whilst twenty acres of other land acquired by the company affords connections with the large unloading docks of the Staffordshire and Worcestershire Canal Company and the Great Western Railway.

Before considering the station in detail, however, something should be said concerning the company's area of supply. The Shropshire, Worcestershire and Staffordshire Electric Power Company, incorporated in 1903 as the Shropshire and Worcestershire Electric Power Company, came under its present control in 1908 and has grown continually until it is now one of the great supply systems of the country, linking up with other supply systems, notably that of Birmingham, and having distribution powers over a wide "Avon Valley" area, the total area of supply approximating 1412 square miles. Besides the new station at Stourport the company owns a large station at Smethwick, a station at Redditch, and has acquired other stations at Dudley, Kidderminster, Ludlow, and Tewkesbury; but in due course these stations will be shut down and supplies will be drawn from Stourport.

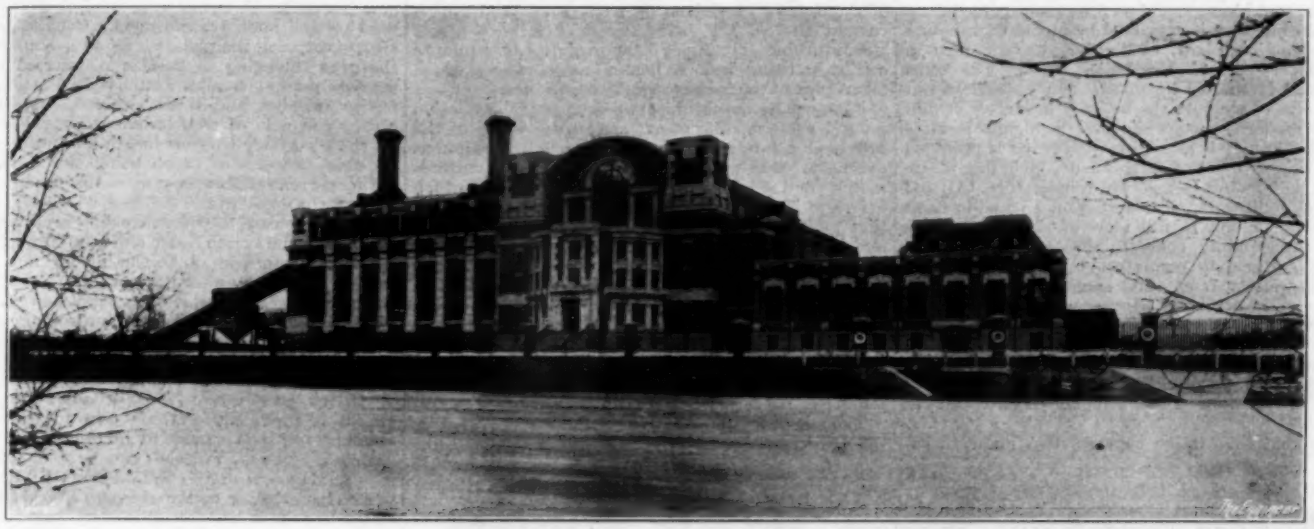


FIG. 3—EXTERIOR VIEW OF THE STOURPORT ELECTRIC POWER STATION

As will be seen from the plan, Fig. 4, the boiler-house of the new station forms a tee with the main engine-room, and it is 139ft. 6in. long, 88ft. wide, and 74ft. high, whilst the dimensions of the turbine house and offices combined are 170ft. by 107ft. 6in. by 85ft. high. Besides Oldbury and Smethwick, the important industrial areas of Halesowen, Dudley, Kidderminster, and Redditch are served. The towns of Droitwich, Bromsgrove, Upton-on-Severn and the intermediate country are also supplied. Villages, and in many cases isolated farms, now derive electricity from the extensive network of underground and overhead conductors that serves this large area, covering practically the whole of Worcestershire, the southern portion of Shropshire, and portions of Staffordshire in the south of that county. The company has also been entrusted with the electricity supply in what is known as the

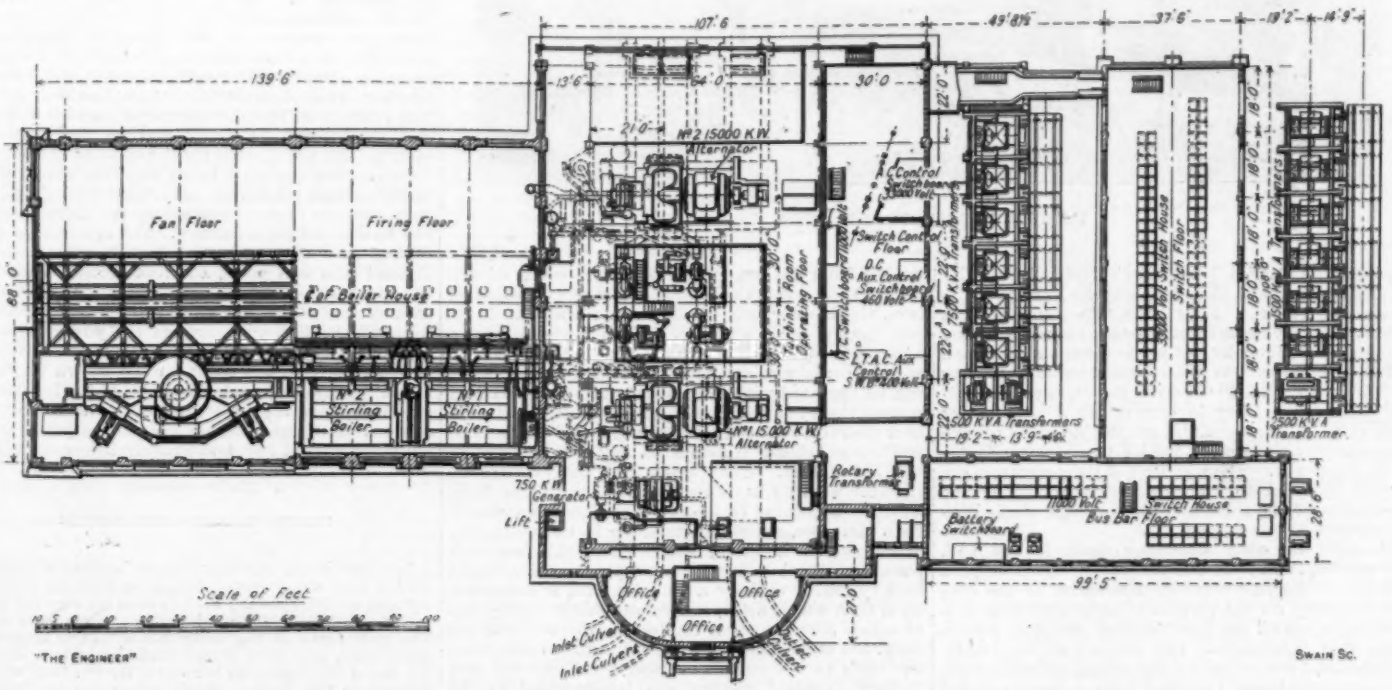


FIG. 4—PLAN OF THE POWER-HOUSE

There is an 11,000-volt switch-house and a 33,000-volt switch-house, which is 99ft. long, 37ft. 6in. wide and 50ft. high, whilst the 11,000-volt switch-house is 99ft. 5in. long, 28ft. 6in. wide and 36ft. high. With the coal and ash-handling plant we shall deal in detail in our next article, and we now pass on to the boiler plant. The steam-raising equipment, supplied by the Stirling Boiler Company, Ltd., comprises four Stirling "Tri-drum" water-tube boilers with integral superheaters and Babcock and Wilcox horizontal steel tube economisers. In accordance with modern practice, a closed feed water system is employed. The make-up is evaporated and a preliminary heating is obtained by means of heaters supplied with steam bled from the turbines, but live steam from the boilers may also be used for that purpose. At a temperature of 150 deg. Fah. the feed water enters the economisers, and before it enters the boilers its temperature is raised to 250 deg. Fah., a steady feed being maintained by means of Cope's automatic feed water regulators. Each boiler, which has a heating surface of 11,000 square feet, is normally capable of evaporating 60,000 lb. of water per hour to steam at a pressure of 350 lb. per square inch, superheated to a total temperature of 725 deg. Fah. Under overload conditions the four boilers are capable of supplying 400,000 lb. of steam per hour at the pressure and temperature mentioned.

Under each boiler there are two Babcock and Wilcox forced draught component-type chain grate stokers, with a combined grate area of 324 square feet, and each stoker is capable of burning up to 3 tons of coal per hour. To enable the plant to continue to operate in the event of a failure in the coal supply, auxiliary oil burning equipment is fitted. The steam-raising units are installed in pairs, and each pair is arranged to discharge the gases by means

of induced draught fans, through a Sirocco dust catcher, situated at the base of a steel stack common to the two boilers. An induced draught fan is fitted to each boiler on a special floor immediately above the economisers, but entirely walled off from the boiler house and coal bunkers. The forced draught fans are situated in a room in the boiler house basement, entirely separated from the ash-removal plant. Each boiler is equipped with a separate forced draught fan, but if required the two fans of each pair of boilers can send the air through a common duct. Avery automatic weighing machines specially designed for weighing wet slack are fitted to each stoker hopper. The steam-raising units are also fully equipped with Diamond soot blowers, and pockets are provided from which the flue dust is extracted by means of a suction dust extraction plant, which deposits the dust in a container outside the boiler house. The soot-blowing and removal operations can be carried out irrespective of whether the boiler is in service or not. As in all modern stations in which the highest possible thermal efficiency is aimed at, each boiler is provided with a complete set of instruments, including steam and air flow meters, temperature indicators, CO_2 and excess air indicators, all mounted on a panel in front of each boiler and in full view of the boiler house staff. Immediately beneath these panels are the starters and shunt regulators for the forced and induced draught fans, thus enabling the operators to make all the necessary adjustments with the instruments in view. A Venturi meter is connected in each of the two boiler feed ranges, and each meter is provided with indicating and integrating mechanism, so that by isolating any boiler on either of the two feed ranges evaporation tests can be carried out as required.

At present the station contains two main turbo-generator sets and a house service set, all built by the British Thomson-Houston Company. Each of the main sets—see Fig. 1 on page 626—consists of a B.T.H. single-cylinder fourteen-stage impulse turbine, running at 1500 revolutions per minute, and driving a B.T.H. alternator, with a maximum continuous rating of 22,500 kVA at 0·8 power factor, and generating three-phase 25-cycle current at a pressure of 5500 volts. The alternators are also designed to give a maximum output of 22,500 kVA at a power factor of 66·6 per cent. The windings of the generators are directly coupled to transformers, which raise the pressure to 33,000 volts, at which pressure the switching operations are carried out.

Mounted on each alternator shaft is 250 kW, 440–460-volt, shunt-wound generator, which supplies current to the motor-driven auxiliaries of the set; but it is only during periods of light load that it is possible to run all the direct-current auxiliary motors from these generators. The alternators are totally enclosed and are cooled on the closed circuit system, each machine being provided with a direct-coupled exciter. In accordance with modern practice, distant thermometers, made by the Cambridge Instrument Company, are used to indicate the temperatures of the stator and rotor, and that of the air at inlet and outlet of the machine, and at other important parts of the system. The house set consists of a B.T.H. turbine running at a speed of 6000 revolutions per minute, and driving, through gears made by the Power Plant Company, a 750-kW generator running at a speed of 600 revolutions per minute and generating at a pressure of 460 volts. For a period of two hours the set is capable of developing 25 per cent. overload.

All the condensing plant, including that for the house service unit, was supplied by Cole, Marchent and Morley, Ltd. Each of the main condensers—see Fig. 2, page 626—has a cooling surface of 25,000 square feet, and is designed to maintain a vacuum of 29in. when dealing with 150,000 lb. of steam per hour, with a circulating water supply at the rate of 1,050,000 gallons per hour at a temperature of 55 deg. Fah. The condensers are of the two-flow type, and have divided water heads, so that one-half of the condenser tubes can be cleaned without shutting down the plant. In each case there is a duplicate set of Delas steam jet air extractors, and each extractor is capable of the full duty. There are also two circulating water pumps for each unit, either of which is capable of delivering to the condenser 60 per cent. of the total water required. One of these pumps is driven by a variable speed direct-current motor, the other by a 210 horse-power steam turbine, running at 5000 revolutions per minute and exhausting into a heater surge range, which forms part of the feed heating system.

Each condenser also has two condensate extraction pumps, each capable of extracting the whole of the full load condensate plus 25 per cent. continuous overload. One pump is driven by a direct-current motor, and the other by a steam turbine which exhausts into the heater steam range. The extraction pumps discharge into the closed feed system, and the temperature of the condensate is increased in the following manner:—From the condensate temperature of 73 deg. Fah., the temperature rise obtained by passing it through the air extractor heater is 7 deg., that due to passing it through the drain cooler heater 2 deg., and the rise obtained by passing it through the main feed heater 68 deg., so that the temperature of the condensate entering the feed pumps is 150 deg.

The steam for the main feed heater is provided by the exhaust from the various auxiliaries and the vapour from the evaporator or, in the event of this being closed down, the requisite heat can be obtained from the bleeder belt of the main turbine at 11 lb. per square inch absolute. Each turbine has a separate evaporator normally supplied with steam at 80 lb. per square inch, but, if desired, the evaporators can be operated with live steam. In the closed feed system there is a cushion or surplus tank, which acts as a reservoir between the condenser and the boilers, and automatically responds to any irregularities in the boiler feed. The product of the evaporator, together with all drain recovery, is led to this tank, which is connected to the top of the main condenser by a 3in. pipe, delivering make-up to the main condenser for de-aeration, after which this water is passed to the closed feed system proper. The closed feed system is entirely automatic, and is controlled by a float which actuates two automatic valves, one of which allows surplus condensate to pass into the tank, the other allowing make-up water to pass from the tank to the condenser, and thus into the feed system. Venturi meters are incorporated in the condensate and make-up water pipes. These meters are fitted with indicating, recording and integrating movements, so that a continuous check can be kept on the overall efficiency of the turbo-alternator. Besides the 750-kilowatt house set, there is a 750-kilowatt rotary converter and another converter of the same capacity is to be installed. This auxiliary equipment has been provided to supply direct current to the station auxiliaries and lighting, and, if required, the direct-current auxiliaries can be run off the station bus-bars. Some of the auxiliaries around the power house are driven by alternating-current motors, the supply being given by two 500-kVA transformers.

As we have said, all the main switching operations are carried out at a pressure of 33,000 volts, and in order to raise the generator pressure to that value each alternator is directly connected to a bank of three single-phase outdoor transformers with a ratio of 5500/33,000 volts. The main section of the switchgear (designated Section A) is designed to deal with current at the latter pressure, and it and all the other switchgear in the station was supplied by the British Thomson-Houston Company. Apart from instrument transformers and neutral earthing gear, there is nothing between the turbo-alternators and transformers. Each generator has a circulating current system of protection. Time limit overload devices are also provided, so that in the unlikely event of the protective gear failing the faulty section would be switched out, the same system of protection being used on the main transformers. Concrete cell type switchgear with the phases isolated is employed, and the gear belonging to Section A referred to above consists of two generator switches, two main outgoing feeder switches and three switches controlling the 33,000-volt side of transformers giving 11,000 volts on the secondary side for local distribution systems, the final pressure of which being 400 volts. Alternating current at this pressure is also used for driving some of the auxiliaries.

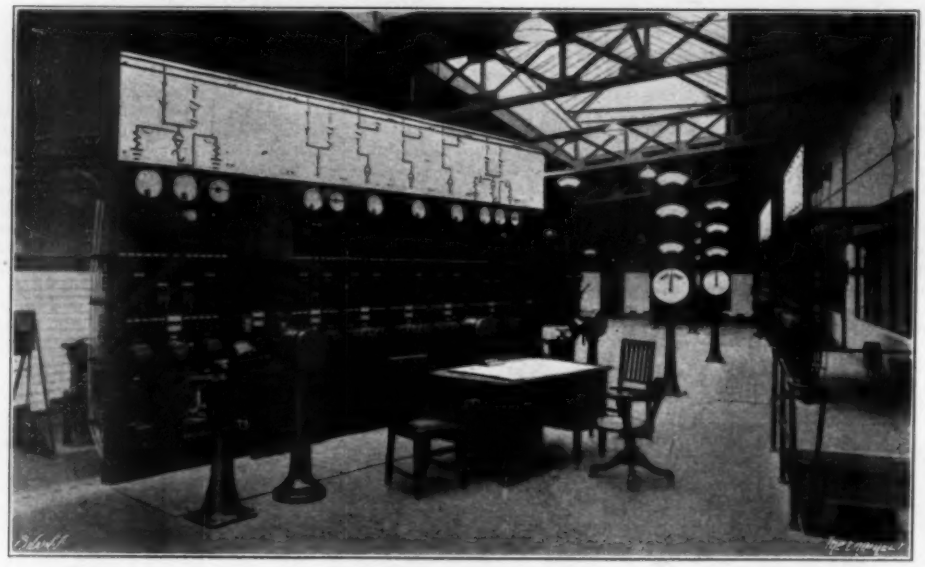


FIG. 5—SWITCHGEAR CONTROL ROOM

The single-core 33,000-volt cables are brought into the base of the switch house and pass through various current transformers on to the bus-bar and isolating switch floor, and after leaving the main isolating switch the current passes through one of two oil switches, thus enabling connection to be made to the main bus-bars or auxiliary bus-bars. Duplicate oil switches are provided for all the main circuits, but in the case of the step-down transformers, giving a secondary pressure of 11,000 volts, only one oil switch is provided, and selection to the main or auxiliary bus-bars is made by hand-operated isolating switches. The oil switches are remotely controlled in accordance with the well-known B.T.H. system, in which an electric motor winds up a powerful spring, and when it is required that the switch shall be operated a catch is released, and the spring moves the switch through practically the full distance, the last part of the movement being made by the motor. At the same time another set of springs is wound up by the motor for the return motion. The B and C sections of the switchgear operate at 11,000 volts, and in this case the gear is operated by solenoids.

The gear associated with Section B controls the outgoing cables for local distribution, whilst that belonging to Section C controls the alternating-current motors driving auxiliaries and the workshop motors. In addition to obtaining its supply through the step-down transformer from Section A, Section C can also be interconnected with Section B.

For low-tension distribution in the station there are special switchboards. Two 500 kVA three-phase transformers are controlled on the 11,000-volt side by switches in Section C, and the transformers deliver alternating current to the low-tension switchboard at a pressure of 400 volts. A direct-current switchboard is fed from the 750-kilowatt house set from the 750-kilowatt rotary converter and from the auxiliary generators directly coupled to the turbines. The pressure on this direct-current board is 460 volts and the current is distributed on the three-wire system. All the current for the auxiliaries driven by direct-current motors is taken from this board, which, under normal conditions, also feeds the lighting circuits; but in cases of emergency the lighting supply can be drawn from a battery. The low-tension alternating and direct-current switchboards are both divided into two parts, the first section controlling the input of energy on the low-tension system and transmitting it by bus cables to the second board, from which all circuits around the power-house are controlled. The 33,000 and 11,000-volt switchgear is operated from the control room shown in Fig. 5, where the input or control sections of the low-tension switchgear are also placed, whilst the distribution sections of the low-tension gear are situated in the auxiliary control bay immediately below the control room.

(To be continued).

As related in our "Railway Matters" column of December 3rd last there was a collision during the dense fog of November 25th outside Finsbury Park Station between the up day Scottish express and the afternoon express from Leeds. The home signal at Harringay was at danger against the latter train, and when it had nearly come to a stand at the signal the signalman lowered it for the train to draw forward to the starting signal, which the man kept at "danger." The fogman stationed at the home signal should have shown a green light to the driver and verbally warned him that the starting signal was "on." Instead of that he showed the green light and added "Right away." Unfortunately a platform porter who was close to the signal at the time and nearer the driver than the fogman, repeated the verbal instruction and led the driver to believe that the road was clear to Finsbury Park. His engine exploded a detonator at the starting signal, but he assumed that it was for the distant on the same post so proceeded cautiously on his way, but ran into the train from Edinburgh, which was standing at Finsbury Park home signals. In his report on the accident, Colonel Sir John Pringle urged standard verbal instructions for fogmen; a differentiation in the number of detonators so that the one explosion for a stop signal could not be taken for the warning of a distant signal, and pointed out that automatic train control at the starting signal would have prevented the collision.

Railway Matters.

THE Great Western Railway employs 110,000 men, and for every minute of the day and night £40 has to be found to pay the company's wages bill.

THE Dublin and Lucan Railway—an electrically-operated 3ft. 6in. gauge railway—has been sold to the Dublin United Tramways Company.

THE Ministry of Transport inquiry into the collision of May 14th at the London, Midland and Scottish Station in Sheffield was held by Colonel Sir John Pringle. The driver of the light engine admitted that he moved out of No. 9 platform road without noticing that the signal was against him, and his engine thus caught the incoming up Scottish express.

WHEN the Irish National Wages Board was recently considering the proposal to reduce the wages of certain grades on the Belfast and County Down Railway, the chairman made a remark which one of the men's representatives claimed was that of an advocate for the company. As the withdrawal of the remark was refused the chairman resigned and left the room.

TWO years ago the work of strengthening the Murray Bridge, at Echuca, in Australia, in order to make it strong enough to carry the heaviest engines used by the Railways Department, was begun, and was completed recently. Severe tests were carried out with an engine weighing 128 tons, and proved entirely satisfactory. The system of strengthening adopted was that of electric welding, and the bridge is probably the first structure of its kind to be treated by this method. While the work of strengthening was being carried out the bridge was widened by the construction of a cantilever footway on one side.

THE Southern Railway Company is issuing some new stock, and has repeated the experiment made in October, 1925, of making it easy for its own servants to subscribe, and thus to have an interest in the company they serve. A leading article in *The Times* of May 20th, in praise of the company's intentions, has prompted a communication from Sir Josiah Stamp, the President of the London, Midland and Scottish, which says that the recent issue of redeemable debenture stock by that company led to 1700 applicants from its employees for £170,000 of stock. The men included 150 drivers and firemen, 109 signalmen, 153 artisans, and 174 of the platform staff.

IN the report for 1925–26 of the Indian Railway Board mention was made of two railways in the Punjab—the Shahdara–Narowal and the Amritsar–Narowal. The former was originally projected as an alternative to the latter, which was to be an extension of the already opened Sialkot–Narowal branch. The report observed that it had then been decided to construct both sections simultaneously, the Shahdara–Narowal section being a joint enterprise of the Government of India and the Punjab Government. Both sections, it was said, would traverse highly cultivated and thickly populated areas in need of improved transport facilities. The Shahdara–Narowal section was opened in December last, and Indian mail advices now report that the Amritsar–Narowal was brought into use on May 4th. The latter is 39·78 miles long, of the 5ft. 6in. gauge.

IN a Seven-day Journal note appearing in this issue we refer to some names of eminent engineers and industrialists who appeared in the list of Birthday Honours issued on Friday last. In addition to those mentioned in that note are Lord Lambourne, who was a director of the London and North-Western, who receives the G.C.V.O., and Mr. Donald A. Matheson, the late deputy general manager for Scotland of the London, Midland and Scottish, who is made a M.V.O. Colonel Murrough J. Wilson, a director of the London and North-Eastern, is created a K.B.E., and among those who have received the C.B.E. are Mr. John Powter, director of the Jamaica Government Railways; Mr. G. H. Griffith, deputy general manager of the Egyptian State Railways; Mr. A. C. Parker, the general manager of the Sudan Government Railways; and Mr. E. W. Rowntree, the Assistant Secretary, Railway Department, Ministry of Transport.

THERE are various ways in which the rates and charges sections of the United States Transportation Act, 1920, differ from our Railways Act, 1921. In the former any income received by the railroad companies in excess of what the Inter-state Commerce Commission lays down as a fair return has to be paid to the Commission to be part of a general railroad contingent fund; in this country 80 per cent. has to be devoted to reducing rates. In the United States, again, the charges are to be such as will bring in 6 per cent.—now 5½ per cent.—on the railroad's aggregate property value; here they are to be such as will bring in the same income as in 1913. Mention is now made of these differences because in a recent case the Inter-state Commerce Commission said that the value laid down in the Act was the value of the property in 1914 when the Valuation Act was passed, and not, as the companies contended, the value to-day.

THE report of the Canadian National Railways engineering party, which was engaged between January 9th and April 4th on the survey of a possible route for the Hudson Bay Railway, has been presented. It appears that the engineers find that it would not be more difficult to build and maintain a line to Fort Churchill than in some other parts. The line as surveyed towards Fort Churchill would leave the existing line at about mile 357 and be 154 miles in length, as compared with 67 miles if the line were taken to the terminus at Port Nelson. The estimated cost of the Churchill route is 7,543,000 dollars, as compared with 2,458,000 dollars for the Port Nelson route. Both estimates include 500,000 dollars for the railway terminus. The engineers believe that the Churchill line could be completed by the end of 1929 and the Port Nelson line by the end of next year. In this connection the Department of Railways issues the following statement: "The information secured by this survey will be most useful when, during the course of the summer, the Government is in possession of the report of Mr. Frederick Palmer, the British harbour expert, who has been engaged to investigate the relative merits of Port Nelson and Churchill as the Bay terminals of the railway."

Notes and Memoranda.

ONE industrial use of cellulose acetate which is gaining ground in France is, says the *Chemical Trade Journal*, its substitution for ebonite in the manufacture of storage batteries, particularly for submarines. It is claimed that battery cases made from cellulose acetate are less liable to breakage, more easily worked, and offer strong resistance to water, oil, grease, petrol, turpentine, &c.

AN article in *L'Elettrotecnica* describes some large transformers which are now being put into service in Italy. These units are designed for operating 130,000 volts plus 10 per cent., and are being followed by other units now under construction of 50,000 kVA., stepping up from 130,000 volts to 220,000 volts. It is stated that a short circuit test for a period of five minutes with a 150,000 kVA generating plant was applied, and successfully withstood, demonstrating the enormous strength of the whole construction, and the efficiency of the cooling ducts.

IN his general remarks on the explosion of a tube in a steam-heated baker's oven, the Board of Trade Surveyor says:—"Having completed several inquiries into explosions of steam-heated ovens, and inspected many tubes that have failed, I am impressed by the similarity of failure in all cases. The tubes invariably failed at the welds, the lines of fracture were in all cases similar to that described above, and the failures were not accompanied by an increase in the actual peripheries of the tubes. These facts, it is thought, point to one conclusion only, viz., that butt welding of tubes which are to contain steam and water at a high pressure and a correspondingly high temperature is not good practice."

"A WIRELESS Works Laboratory" was the title of a paper read by Mr. P. K. Turner at a recent meeting of the Wireless Section of the Institution of Electrical Engineers. The paper presents details of the equipment of a laboratory devoted to the problems of broadcast reception. Among the special equipment developed are: Galvanometer lamps; a distribution system for battery d.c. supply; an elaborate valve tester; an audio source; a standard valve voltmeter; a combined a.c. and d.c. bridge; and interchangeable high-frequency resisters. Special methods are described in connection with insulation tests of condensers; correction of wattmeter errors; measurement of amplification; self-capacity of coils and their high-frequency resistance; and keeping records.

A TYPE of double pavement has been put into use on several important streets in Paris. It consists of a foundation layer of asphalt and a surface layer composed of a mixture of bitumen, rock asphalt and porphyry gravel, to take the place of asphalt, which is dangerously slippery in wet weather. This surface is slightly corrugated, and both layers are applied hot. Compressed asphalt is being used for new street surfacing in places where vehicular traffic is light or cannot attain high speed. The use of cement concrete is being extended in streets where the traffic is very heavy, and special bricks, in which sandy matter has been mixed to increase their resistance, are being tried. A test section, containing different samples of pavement laid at the expense of the contractors, has been established at the end of the Austerlitz Bridge where traffic is heavy.

SUCCESSFUL television over 438 miles of telephone line between London and Glasgow is said to have been accomplished by Mr. John L. Baird. The experiments were made on May 26th, and are said to be preliminary to further experiments to be made shortly in attempts to bridge the Atlantic between London and New York. Mr. Baird's improved receiver is stated to embody many important technical advances, including a rapidly obtained synchronisation between it and the transmitter. Subsequently this receiver will be installed in a building in New York, and immediate preparations made for an experimental trans-atlantic transmission by wireless. In the London-Glasgow transmission two telephone lines were used, one for conversation and the other for television, and it is reported that the received image, though small, was clear and distinct, revealing such movements as the turning of the head, opening and closing of the eyes, moving of the lips in speech, &c.

COMMENTING on the failure of a vertical boiler in a recent official report, the Engineer Surveyor-in-Chief, Board of Trade, says:—"The boiler in this case was of very unusual design and the arrangements for filling it with water after it had been cleaned were very unsatisfactory. When it was ready for filling, as much water as could be run in from a service tank by gravity was admitted, and although the level was then unknown steam was raised, so that the feed pump could be used to pump in the remainder of the necessary supply. Such a haphazard practice was likely to lead to accident, and eventually, owing apparently to stoppage of the inlet pipe, the amount of water run in was much less than expected, leading to overheating and serious damage to the fire-box. Had the manhole door been left off while the water was being run in or a test cock been fitted, the attendant could have ascertained that the tube plate was sufficiently covered for safety."

THE recently issued seventh annual report of the British Non-ferrous Metals Research Association for the year ended December 31st, 1926, gives a brief summary of the scope of some twenty-seven researches which have been carried out during the period under review, and in some cases are still proceeding. A wide field of investigation is covered, including such problems as atmospheric corrosion, the production of sound castings, copper locomotive fire-box stays, "wiped" plumbers' joints, die casting alloys, materials for high-temperature service, and electro-deposition. New and projected research work will include an investigation of the galvanising process and its products, the causes and prevention of "spotting-out" on finished brass castings, and an investigation of the process of nickel plating. Several translations of important articles published abroad have been made, and the Association is now engaged in preparing a data book on light alloys for castings, which will summarise scattered information regarding these alloys in a manner which should be of interest to both the producers and the users of such materials.

Miscellanea.

IT is proposed to provide Chungking, Szechwan Province of China, with a water supply at a cost of about £60,000.

THE invention by Fourneyron of the type of turbine bearing his name is to be celebrated on June 11th by the Société des Ingénieurs Civils de France at 19, Rue Blanche, Paris.

THE new dock at Workington will be opened on June 30th by his Royal Highness the Prince of Wales. It is understood that the dock will be ready for use by the end of May, but a good deal remains to be done around it, involving probably four or five months' work.

IT is announced that the Darlington Forge, Ltd., has completed the fourth and last of the bearings for the Sydney Harbour, bridge the contract for the supply of which was let to them by Dorman, Long and Co., Ltd., of Middlesbrough. Each bearing weighs 300 tons. The first has already been delivered in Australia.

ACCORDING to the *Iron and Coal Trades' Review*, the Wemyss Coal Company, Ltd., East Wemyss, is sinking a shaft the diameter of which is claimed to be the largest in Great Britain. The shaft, which is at present sunk to 102 fathoms, is 24ft. inside diameter, and when completed will be 300 fathoms deep.

WORK is to be stopped at the Barrington Colliery of the Bedlington Coal Company, Northumberland, for the purpose of carrying out extensive improvements. These include the substitution of electricity for steam as the motive power for the pit machinery and alterations to the shaft. An order for an electric winder has been placed with Metropolitan-Vickers, Ltd.

SOME ingots of basic open-hearth steel, measuring 28in. by 90in. by 100in., and weighing 63,000 lb. each, were rolled into slabs 130in. wide, 200in. long, and 8¼in. thick recently on the 206in. plate mill of the Lukens Steel Company, Coatesville, Pa., U.S.A. The slabs were subsequently converted into discs, 121in. diameter, 8¼in. thick, for fly-wheels to be used on a large gear reduction unit.

THE Federal Radio Commission has directed all stations to announce their call letters and location once every 15 minutes at least. It has also ordered that all stations must not deviate more than half a kilocycle from the wave lengths assigned to them. Owing to constant complaints of interference caused by broadcasting stations using too much power within residential sections of Chicago, three of them have been directed to reduce their maximum power output to 500 watts, effective at once, and to use no more until further notice.

THE trials of the Blue Star Liner, Arandora, on the Clyde on the 30th ult., marked the completion of an exceptionally speedy shipbuilding programme, for the Arandora is the fifth liner of the company to be commissioned within a period of five months for the new London-South America passenger service. She was built by Cammell Laird and Co., Ltd., and was launched on January 4th last. The Almeda and the Andalucia were also constructed by that firm, and the Avila and Avelona by John Brown and Co., Ltd., on the Clyde. On Wednesday, June 8th, the Lord Mayor of London, as Admiral of the Port of London, paid a visit to the Arandora at the Royal Albert Docks.

AT the end of 1926 the hydro-electric development of Switzerland amounted to 1,867,000 H.P. Of this total 46 per cent. was developed by private undertakings, 17 per cent. by local authorities, 26 per cent. by Cantonal and other authorities, and 11 per cent. by the Swiss Federal railway authorities. The important new plants completed during last year included the Ober-Ems station of the Illsee-Turtmann Gesellschaft and the Reichenbach station of the Reichenbach Elektrowerke Gesellschaft of Meiringen. New stations in course of construction and extensions to existing stations will, when completed, bring the total capacity of hydro-electric plants up to 2,241,000 H.P.

ACCORDING to the report for 1926 of the Union of Electricity Works, the total capacity of the German electricity stations amounted to 5,700,000 kW, as compared with 5,000,000 kW for the previous year. The running of the works was normal, although sales of electricity for power purposes suffered considerably from the depression in industry. Only in the last months of the year did industrial consumption of power begin gradually to increase, and there was a rise in output from 11,700,000,000 kWh in 1925 to 12,100,000,000 kWh in 1926, or about 4 per cent. The use of electricity in homes, however, increased considerably, and was large enough in many places to make up for the falling off in sales to industries.

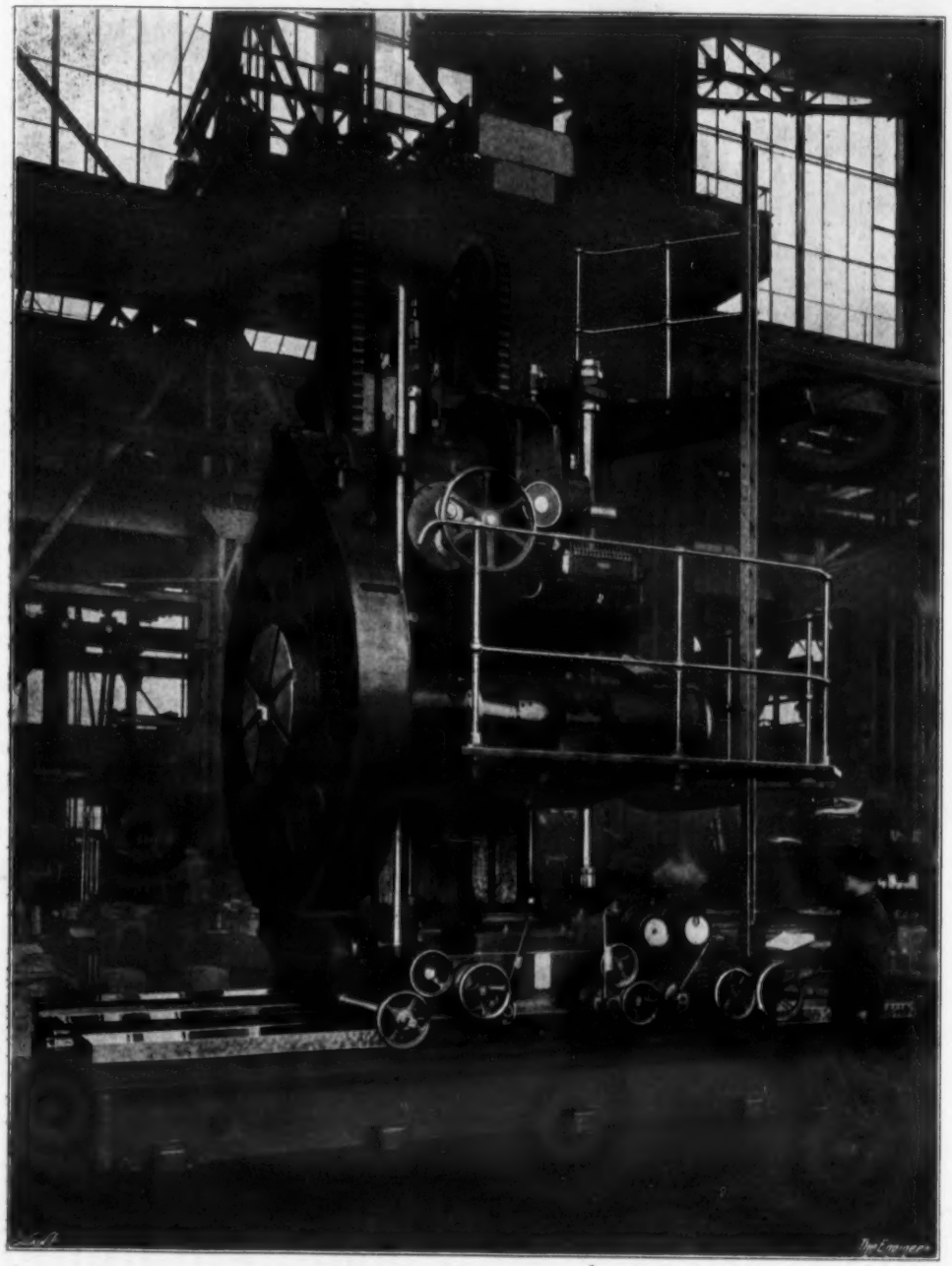
PROBLEMS relating to safety in coal mining have for long exercised the minds of those engaged in the industry, and among such problems that of the behaviour of coal dust in mine explosions has proved the most difficult of solution. On Tuesday, June 14th, Viscount Chelmsford, chairman of the Miners' Welfare Committee, will open the new safety in mines research station, which has been built by the Research Board at Harpur Hill, Buxton, to replace the Eskmeals experimental station, and among the matters to be investigated by the station will be the study of coal dust and fire-damp explosions, gob fires, and mining explosives. A useful guide to the station, containing a full description of the plant and instruments, has been published, and may be obtained from H.M. Stationery Office.

THE Birmingham Public Works Committee propose drafting by-laws for the control of wireless aerials. The proposed by-law applies to a person who shall stretch or place on or over any premises any apparatus which is liable to fall on to any street or public place, and requires: (1) The apparatus to be securely attached to adequate supports of durable material; (2) every support for the apparatus to be efficiently secured against force due to ice loading and wind pressure, or to the accumulation of snow or sleet; (3) the apparatus, if attached to a chimney, wall or other part of a building, to be efficiently supported by angle plates of iron or some other suitable device; (4) the apparatus to be so stretched, placed, and maintained as not to be dangerous or to cause obstruction to persons using any street or public place.

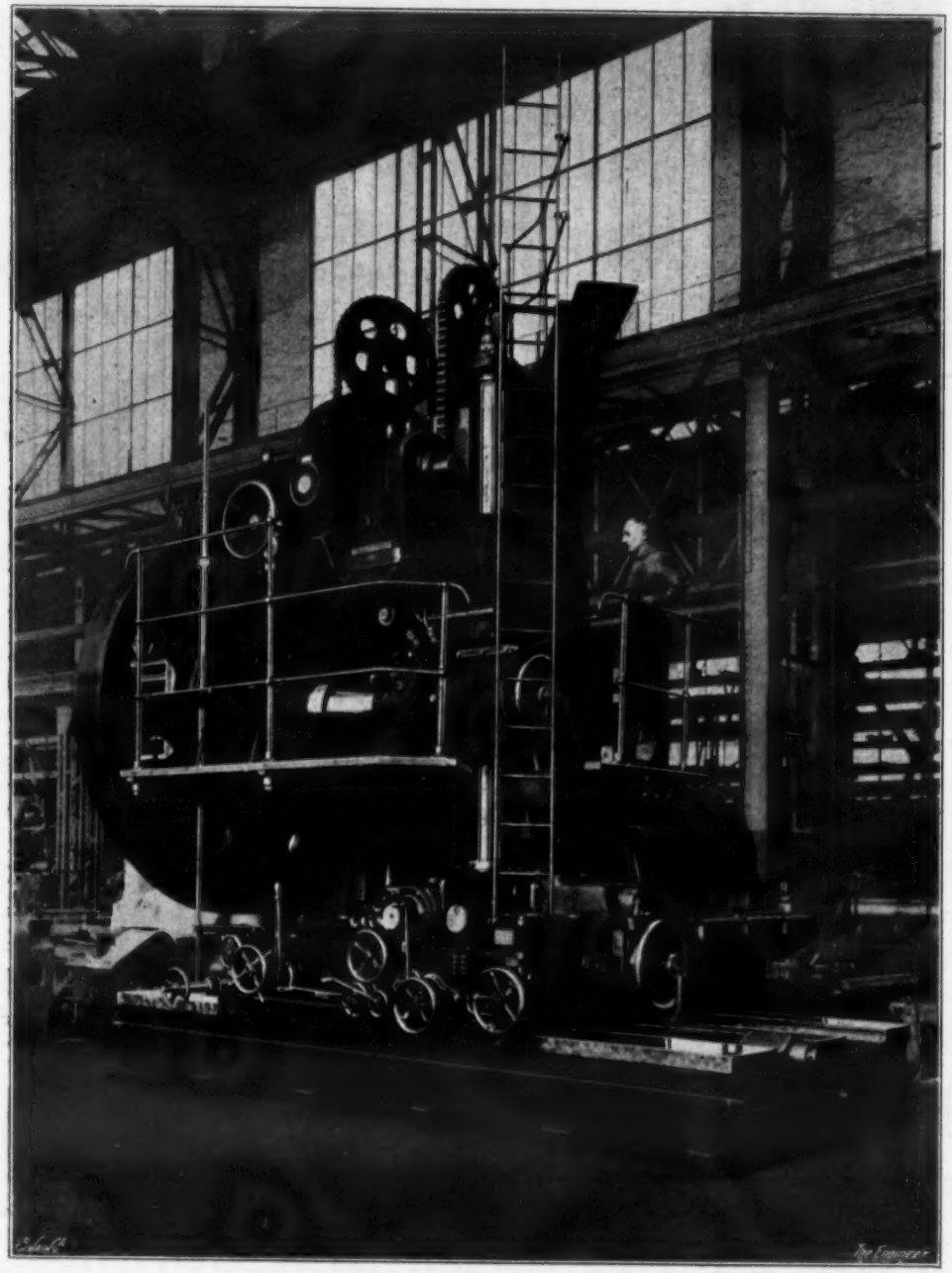
LARGE HORIZONTAL BORING MACHINE FOR TURBINE CYLINDERS

THE SCHIESS DEFRIES A.G. DUSSELDORF, ENGINEERS

(*For description see page* 635)



FRONT VIEW OF MAIN STANDARD



REAR VIEW SHOWING DRIVING MOTOR

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.

CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.

EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.

FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris.
CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.

GERMANY.—FRITZ RENFUS, Blumenthalstrasse, 10, Cologne.

BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

INDIA.—A. I. COMBRIDGE AND Co., Bombay; THACKER AND Co., Limited, Bombay; THACKER, SPINK AND Co., Calcutta.

ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umberto 1, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.

JAPAN.—MARUZEN Co., Tokyo and Yokohama.

AFRICA.—WM. DAWSON AND SONS, Limited, 7, Sea-street (Box 49), Capetown.
C. JUTA AND Co., Johannesburg, East London, and Grahamstown.

AUSTRALIA.—GORDON AND GOTCH, Limited, Melbourne, Sydney, Brisbane, and Perth, &c.
MELVILLE AND MULLEN, Melbourne.
ATKINSON AND Co., Gresham-street, Adelaide.

CANADA.—DAWSON, WM., AND SONS, Limited, 87, Queen-street East, Toronto.
GORDON AND GOTCH, Limited, 132, Bay-street, Toronto.
MONTREAL NEWS Co., 386-388, St. James-street, Montreal.
TORONTO NEWS Co., 42, Yonge-street, Toronto.

CEYLON.—WIJAYARTNA AND Co., Colombo.

JAMAICA.—EDUCATIONAL SUPPLY Co., Kingston.

NEW ZEALAND.—GORDON AND GOTCH, Limited, Wellington and Christchurch; UPTON AND Co., Auckland; J. WILSON CRAIG AND Co., Napier.

STRAITS SETTLEMENTS.—KELLY AND WALSH, Limited, Singapore.

UNITED STATES OF AMERICA.—INTERNATIONAL NEWS Co., 83 and 85, Duane-street, New York; SUBSCRIPTION NEWS Co., Chicago.

SUBSCRIPTIONS.

THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.

Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post Office Order must be made payable to THE ENGINEER and accompanied by letter of advice to the Publisher.

THIN PAPER COPIES.	THICK PAPER COPIES.
Half-yearly .. £1 11s. 6d.	Half-yearly .. .. £1 13s. 9d.
Yearly .. .. £3 3s. 0d.	Yearly .. .. .. £3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 18s. 6d. per annum.
Thick paper edition .. £3 5s. 0d. "

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

ADVERTISEMENTS.

*** The Charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "THE ENGINEER DIRECTORY," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication). ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

"THE METALLURGIST"—BINDING CASES.

Cloth Binding Cases for twelve issues (one year) .. .. 2s. 0d.
Subscribers' own copies, including cases, bound Cloth .. 4s. 0d.
Bound half roan 7s. 6d.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

TO CORRESPONDENTS.

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, June 10th, 1927.	PAGE
A SEVEN-DAY JOURNAL	619
TESTS OF A 2-8-4 TYPE LOCOMOTIVE. (Illus.)	620
INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION. No. II.	622
MECHANICAL VIBRATION FILTERS. (Illus.)	624
THE "IRON BRIDGE" AT PLYMOUTH	625
MANCHESTER ELECTRICITY SUPPLY	625
LETTERS TO THE EDITOR—	
Dearth of Useful British Inventions	625
The Last Beam Engine	625
THE STOURPORT POWER STATION. No. I. (Illus.)	627
RAILWAY MATTERS	629
NOTES AND MEMORANDA	629
MISCELLANEA	629
LEADING ARTICLES—	
Continuous Brakes for Goods Trains	631
The Interpretation of Natural Phenomena	632
A NEW PROCESS OF COMBUSTION FOR HIGH-SPEED HEAVY OIL ENGINES. (Illus.)	632
SIXTY YEARS AGO	633
BOOKS RECEIVED	633
A NEW WIRELESS RECEIVER. (Illus.)	634
LARGE BORING MACHINE FOR TURBINE CYLINDERS. (Illus.)	635
HIGH STEAM PRESSURE AND TEMPERATURE AT CRAWFORD-AVENUE STATION, CHICAGO. (Illus.)	635
THE INSTITUTION OF BRITISH FOUNDRYMEN	637
80 H.P. TURBINE PUMP MOTOR FIRE ENGINE. (Illus.)	638
AMERICAN ENGINEERING NEWS	638
THE INSTITUTION OF MINING ENGINEERS	638
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	639
Lancashire	639
Sheffield	640
North of England	640
Scotland	640
Wales and Adjoining Counties	641
CATALOGUES	641
LAUNCHES AND TRIAL TRIPS	641
CURRENT PRICES FOR METALS AND FUELS	642
FRENCH ENGINEERING NOTES	643
BRITISH PATENT SPECIFICATIONS. (Illus.)	643
FORTHCOMING ENGAGEMENTS	644
PERSONAL AND BUSINESS ANNOUNCEMENTS	644
CONTRACTS	644
PARAGRAPH—Institution of Heating and Ventilating Engineers	641

DEATH.

On May 22nd, at Johannesburg, following pneumonia, Mr. J. H. HUMPHREYES, Chairman and Managing Director of Braithwaite and Co., Engineers, Ltd., of Broadway-buildings, Westminster, S.W. 1.

THE ENGINEER.

JUNE 10, 1927.

Continuous Brakes for Goods Trains.

THE French Government has secured from the railway companies an undertaking to equip all goods trains with continuous brakes. Thus ends a controversy which has been waged for many years concerning the respective merits of continuous-brake systems, and as there is still a great divergence of opinion on this matter, the decision come to in France has very much the appearance of a compromise. In view of the formidable expense involved, amounting to something like 1600 million francs, and of the fact that once a system is adopted there is very little prospect of its being superseded eventually by anything better, the French have long hesitated to settle upon a definite solution. Many trials have been carried out with various brakes—the modified Westinghouse, the Clayton-Hardy vacuum brake and the Lipkowski—and several others were introduced, without, however, being fully tested, but it has been understood all along that the Westinghouse had the preference. There was, of course, the Kunze-Knorr brake which the Germans adopted extensively during the war, in defiance, it is alleged, of the Berne Convention, whereby the selection of a brake for international lines was to be left to an international committee after consideration of reports presented by the various countries. The success of the German brake is undoubted, and it has been adopted more or less officially by many of the Central European countries, while Italy is said to be favourably disposed towards it. In France the idea of employing a German brake could not be entertained, and although the first trials of the modified Westinghouse brake were somewhat disappointing, it has since been improved, and is now giving entire satisfaction and is interchangeable with the Kunze-Knorr brake. There can, of course, be no question now of suppressing the German brake, which has taken such a strong hold upon most continental countries that nothing can now be done except to profit from the terms of the Berne Convention and propose brakes which are interchangeable with the German system. That has been done in the case of the modified Westinghouse brake, and at the request of the French Government it has been approved by Berne, so that nothing now stands in the way of the Westinghouse brake being employed under the same conditions as the Kunze-Knorr.

The necessity of adopting continuous brakes without further delay has become specially urgent in view of the changes which have taken place of late years in the railway organisations of most continental countries. So long as continental railway services were regarded as an essential means of cheap transport, when freights were often reduced to an absurdly low level with the idea of benefiting trade, and the heavy working losses had to be made good by the taxpayer, there was no incentive to improve them, even if the means for doing so were available. The object of the State ownership of railways was to ensure low rates and freights, and was carried to an absurd length in Belgium, and in some other countries, where the railways existed rather as political institutions than as commercial undertakings. The financial upheaval in Europe has changed completely this idea of railway enterprise; as the taxpayer's money is required for other things, there is nothing left to fill up the abyss of railway deficits. One of the first reforms was to ensure that the railways should become self-supporting, and while the French State vainly endeavoured to make over a part of its system to private enterprise, the Belgian Government commercialised the railways, and in Italy the State railways have been subjected to a rigorous economy that would probably hardly be acceptable elsewhere. In France all the railway companies are under the supervision of the Conseil Supérieur des Chemins de Fer, upon which are represented not only the companies themselves, but also the Government and the interests of practically every class of the community. The immediate effect of this organisation was to bring freights up to a level which would permit of the companies avoiding loss, for the withdrawal of the State guarantee threw them absolutely on their own resources. If railway users were called upon to pay considerably more, it followed that they must be offered some compensation, and this was given in the form of improvements which have been carried out on a more extensive scale than during any similar period in the history of French railways. The most urgent need, however, was to give satisfaction to industrial and commercial users who claimed facilities for quicker transport in return for the higher charges. The Government was all the more ready to promise this advantage because it fell in with the general programme of international goods traffic improvement, and also with the plan of the military authorities to accelerate the goods service for the purpose of national defence. If French trucks and wagons were to be allowed to travel over the foreign railway systems, they must be equipped with continuous brakes, and such brakes would also permit of the more rapid concentration of troops who are carried in goods wagons wherever necessary for mobilisation. Apart from accelerating goods traffic, the transformation will have the further advantage of simplifying the railway services generally, since goods trains will travel at little less than the speed of ordinary passenger trains, and time-tables can therefore be arranged as if all the trains, except expresses, were travelling at approximately the same speed.

One of the reasons for the delay in fitting continuous brakes to goods trains in France is the apparent impossibility of supporting such a heavy financial load at a time when it is necessary to pursue a policy of rigid economy. A few years ago a group offered to finance the work under conditions which the Government could not accept. It was then suggested that Kunze-Knorr brakes should be supplied by Germany on account of reparations, and having already obtained satisfaction on the principle of employing the Westinghouse brake the Government gave this proposal favourable consideration, although the mere suggestion that the brakes should come from Germany aroused such violent opposition from French makers of railway material, who were themselves almost entirely devoid of work, that it was found necessary to seek some acceptable compromise. It was obvious that nothing could be done without German aid, and for a long while negotiations were in progress between the Westinghouse Brake Company and the makers of the Kunze-Knorr brake, with the result that a definite proposal was made recently to the French Government. It is understood that both companies will share equally the work of supplying the brake equipments, and a financial arrangement has been come to on the basis of annuities to be paid by the railway companies. In an official statement just issued the Government announces that the Westinghouse brake has been adopted by the French railways, that a proportion of the brakes will be

supplied by Germany on account of reparations, and that work will be provided for French manufacturers. This statement implies that the essential parts of the Kunze-Knorr brakes will be imported from Germany and that the accessory parts will be manufactured in France. The problem of the brakes, so far as the Continent is concerned, is now virtually settled, for the Kunze-Knorr and the Westinghouse have alone received official recognition, and no other brake has been proposed by the countries interested. The field, however, is still left open for other systems, which may be approved by the Berne International Commission on condition of their being interchangeable with the brakes already adopted. It is stated that it will take five years to fit all the trucks and goods wagons in France with continuous brakes, and when that is done, and other countries have adopted the same braking systems, the goods traffic all over Europe will be considerably accelerated.

The Interpretation of Natural Phenomena.

IT is probably vain to hope that scientific knowledge will ever become enshrined in a series of statements or code of laws uniformly distinguished by their simplicity and terseness. The evidence available on the subject seems very strongly to suggest that natural phenomena, so far as man is permitted to understand them, are essentially complex and can only be described in words imperfectly and with much circumlocution. When Copernicus introduced the heliocentric theory, he eliminated a vast amount of complexity from the study of planetary motions and provided astronomers with a new, simple and inspiring basis for their outlook on the heavens. It is possible that some, even many, natural phenomena are to-day being unwittingly approached from a standpoint analogous to that of the pre-Copernician philosophers, and that a sage may yet arise who shall revolutionise and simplify our manner of looking at things. With each passing year, however, the growth of scientific detail would appear to render the task of such a one more formidable and less possible of accomplishment. The chances are becoming increasingly unfavourable to the discovery of some master key that shall unlock the scientific mysteries accumulating around us. Habits of thought acquire momentum in set directions just as certainly as do material bodies, and the longer they are allowed to flow in channels that have been cut for them, the greater becomes the resistance which they show to change. Now and again, we seem to catch a glimpse of what might be could we transfer our physics to some new basis. Sir William Hardy recently showed that certain seemingly very complex lubrication phenomena reduced themselves, when interpreted in terms of molecules, to a form capable of being expressed by laws of extraordinary simplicity, although it appeared almost impossible to explain the connection between such interpretation and interpretation in familiarly used terms. Instances of this nature are strikingly rare. In nearly every case, the farther we penetrate into natural phenomena with the means at our disposal, the more complex do they appear to become, and the farther do we seem to be wandering from a fundamental solution capable of being expressed in simple language.

In 1678 the tag "*Ut tensio sic vis*" seemed to Hooke to sum up all knowledge concerning the elasticity of metals. To-day, it is still of service, so long only as we are not required to penetrate beyond the fringe of the subject. Fundamental research has made it clear that the simplicity of the behaviour under stress of metals as ordinarily presented to us and the simplicity of the "law" whereby we seek to express that behaviour in words, are entirely fictitious and misleading. The postulated proportionality between stress and strain exists only within a narrow range of conditions. It is not a general characteristic of metal as metal, but is a function of the structure and circumstances of the metal. If the structure is simplified to the fundamental limit by treating the specimen in such a way as to convert it into a single huge metallic crystal, Hooke's law fails completely to describe the reaction of the metal to stress. Single-crystal specimens appear to have no elastic limit, and to extend under any straining action entirely by plastic deformation. A single-crystal specimen originally circular in section, does not as usual preserve that sectional form as it draws down under load, but fractures with an elliptical or in extreme cases with a knife edge section—that is to say, by contracting along one diameter while remaining almost unaltered along another. In other ways, too, the single-crystal specimen equally fails to reproduce the simple behaviour of the same metal in the ordinary polycrystalline form. The apparent simplicity of behaviour of ordinary metal under stress stands revealed as a complex function of the complex structure. When the structure is simplified, the simplicity of behaviour vanishes, and we are faced with facts and results of a new and highly involved nature. The behaviour of single-crystal specimens can with some difficulty be explained on a molecular basis. But the task, obviously of much greater difficulty, of explaining the "simple" behaviour of ordinary specimens remains unattempted. Alteration of circumstances produces changes no less striking than those caused by alteration of structure. The simple manner in which a specimen reacts to a slowly increasing load, first extending elastically, then plastically, and finally fracturing, is at total variance with the reaction of the same specimen if the load is fluctuating. The change of behaviour is far greater than the simple change in the manner of applying the load would seem to justify. The characteristics of the metal appear, in fact, to undergo a fundamental readjustment. With a rapidly fluctuating load, it is not the maximum value of the stress which determines whether the specimen will break or not, but the range of stress through which the load fluctuates. That range may involve a maximum stress above the value at which under static conditions plastic deformation sets in; it may carry the maximum stress to within a small percentage of the static breaking load, and even, there are some grounds for believing, beyond that load; yet if the range is suitably adjusted the specimen will survive an indefinite number of applications of it. The "simple" behaviour of ordinary specimens under static loads is an accident of the manner in which the load is applied. It is but a particular phase of a general phenomenon which only a very elementary knowledge could lead us to believe was of a simple nature. So, too, might we write of the behaviour of metals under stress when the temperature is above the normal. At high temperatures metals lose their ability to hold loads indefinitely, a characteristic which at normal temperatures is at the root of their whole value in the constructional arts. The phenomenon of "creep" sets in, and the specimen will fracture under some quite low load after sustaining it for a period of some hours, days or even weeks.

We have drawn our examples wholly from the study of metals and their resistance to loading, but in every other branch of physical knowledge instances are numerous of the principle that natural phenomena as we see them and are permitted to study them rest apparently on a complex basis, and never, so far as has been revealed to us at present, on a simple grouping of primitive facts. Where the phenomena appear simple, there may we most certainly expect fundamental research to disclose the greatest complexity. The desire to have a simple outlook in our efforts to understand natural facts is strongly implanted in all of us, but that it represents any instinctive appreciation of a corresponding simplicity in nature there is not at present the least warranty for supposing. It is much more probably an expression of man's limited ability to understand natural facts or a silent admission of the inadequacy of the mental habits that have been handed down to him from past ages. However it may be, there is a warning obviously to be conveyed. Efforts to interpret Nature in simple terms cannot yield at the best more than an approximately true understanding of her processes, and quite readily may gravely impede the acquisition of increased knowledge. It is fortunately open to us to make practical use of Nature's phenomena without understanding her processes. But it is not in that way that we can hope to achieve progress. We may employ fire to-day with no more insight into the mechanism of combustion than that which was possessed by primitive man. It is to our advantage that we have discovered that perfectly pure dry carbon is incombustible in perfectly pure dry air, and only by pursuing the meaning of that and other facts acquired by minute observation are we enabled to raise ourselves above the level of scientific savages.

A New Process of Combustion for High-speed Heavy-oil Engines.

AN engine with a new development of considerable importance in the design of heavy-oil engines running at high speeds of revolution was described by Professor Dr.-Ing. R. Stribeck, of Stuttgart, in a paper he read at the Summer Meeting of the Verein Deutscher Ingenieure held at Mannheim from May 28th to 30th. This is the "Acro" engine, for which patents are held by the Acro A.G., of Küsnacht a. R., Switzerland. The sole right to grant licences, however, has been acquired by the Robert Bosch A.G., of Stuttgart, who have carried out the tests described in the paper.

The progress of the heavy oil engine in the direction of higher speeds of rotation is naturally bound up with the question of the rate at which the injected fuel can be mixed with the air charge in order to ensure the completion of combustion within a sufficiently short length of time. For transport purposes it is also necessary that the combustion should take place with reasonable efficiency over a wide range of speed. It is in connection with possible improvements in the flexibility of such engines that Professor Stribeck's paper is especially interesting.

Fig. 1 shows the special design of piston at top dead centre in the cylinder of an engine of the ordinary four-stroke type. In this position the clearance volume consists of the four parts: *a*, the compression space in the piston; *c*, the compression space between the top of the piston and the cylinder head—the volume of this space naturally changes as the piston moves down the stroke; *b*, a Venturi or funnel-shaped passage connecting *a* and *c*, of which *d* is the orifice or neck. The fuel is injected into the space *b*. The engine tested was a single-cylinder engine of 125 mm. bore and 180 mm. stroke, with a connecting-rod/crank ratio of 3·8 and with a normal speed of 800 r.p.m. These dimensions gave a swept volume of 2209 cu. cm. The total clearance volume was 140 cu. cm., divided as follows:—*a*, 98 cu. cm.; *b*, 10 cu. cm.; *c*, 32 cu. cm., or 70, 7, and 23 per cent. of the clearance volume respectively. The cross section of *d* was 1·17 sq. cm.

The engine was an ordinary high-speed "airless" injection engine, which was only altered as far as the cylinder head and the piston were concerned. The fuel was injected in the ordinary way directly into

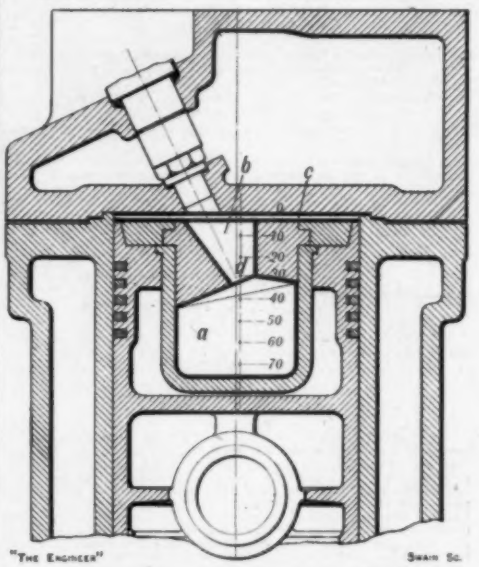


FIG. 1—COMBUSTION CHAMBER OF ACRO MOTOR

the Venturi-shaped space *b*, the fuel valve closing at about 15 deg. after top dead centre.

In order to avoid any confusion between this engine and existing engines in which the combustion spaces are divided into two parts, giving an "ante-combustion - chamber," the author quoted Professor Nägel's statement "that the distinguishing feature of such engines is a definite throttling action in the passage connecting the "ante-combustion-chamber" and the main combustion chamber, the passage being so proportioned that, upon the burning in the former of a portion of the charge, the consequent rise of pressure forces the remainder of the charge at high velocity through the restricting passage."*

Professor Stribeck carried out two series of tests, the first being upon the differences in pressure between the parts *a* and *c* of the compression volume during the compression period. These differences were obtained by connecting the spaces to the two sides of a pressure diaphragm and were recorded by means of a stroboscope. The pressure differences increased steadily up to 20 deg. before top dead centre and then decreased steadily and gave pronounced oscillations about top dead centre.

The second series of tests gave a comprehensive indication of the temperature changes taking place during combustion and expansion at the points marked 10 to 70 in Fig. 1, these numbers giving the distances in millimetres from the under side of the cylinder head to the respective points. The temperatures were read at these points by means of a thermo-element whose position was fixed with relation to the under side of the cylinder head. Thus, during 68 mm. of piston travel the point 70 is within the piston, during 58 mm. of travel the point 60 is within the piston, and so on. All three parts of the com-

* *Z.V.D.I.*, Vol. 67 (1923), p. 778.

bustion chamber were therefore under observation during about 40 mm. of piston travel. Complete tests were made at 400 r.p.m. with a mean indicated pressure of 68 lb. per square inch; at 600 r.p.m. with a mean indicated pressure of 82 lb. per square inch, while isolated points were obtained at 800 r.p.m. Fig. 2 shows the curves of temperature for all eight measuring points, plotted on a base of crank angle, for the series of tests at 600 r.p.m.

In considering these points it was borne in mind that during the power stroke combustion will cause a rise of temperature, while expansion will cause a drop, and that the highest temperatures are reached where the mixtures of fuel and air are in the correct proportions. It is seen from the figure that only at points 0, 10, 20, 30 did the temperature reach a high level, and then only while these points were in the Venturi-shaped space *b* of the piston. It is safe to conclude from the temperature diagrams that combustion takes place almost entirely within *b*, and, from

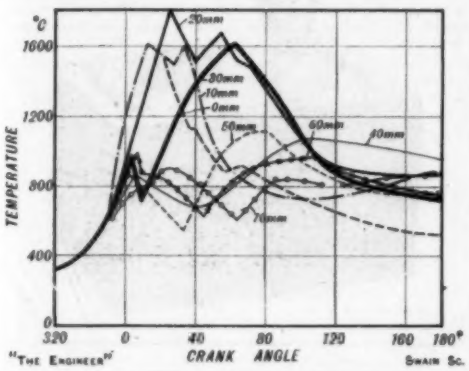


FIG. 2—COMBUSTION CHAMBER TEMPERATURES

the high temperatures reached, that the mixtures of fuel and air are constantly favourable during the combustion period. Taking into account the fact that fuel injection into *b* ceases at 15 deg. after the top dead centre and that the volume of *b* is very small, it can only be possible to maintain combustion in this space over such a long period if fresh air is brought in and the exhaust products are got rid of. It will be understood that as the piston moves downwards the air compressed into *a* during the compression stroke will pass through *b* into *c*; thus *a* provides a reservoir of air which becomes gradually used up during combustion. Apart from the difference of design between this engine and those of the "ante-combustion-chamber" type, it is concluded that these test results demonstrate irrefutably the differences between their respective combustion processes.

In tests at reduced loads it was found that the combustion process was still confined to *b*, but that the temperatures at 0 and 10 were markedly lower, with the consequence that less heat was lost to the cooling water through the head.

Tests made to investigate the effect of speed are especially interesting. The results all show that the hot zone extends about 30 mm. into the cylinder after 8 mm. of piston travel, and that the maximum temperature reached does not differ much for 400 and 800 r.p.m., but at 600 r.p.m. is higher. The figures are:—

Speed, r.p.m.	400	400	600	800
Mean indicated pressure, lb. per sq. in.	47	68	82	77
Highest temperature at 8 mm. piston travel, °C.	1350	1300	1650	1370

The ratios of the times necessary for the same piston travel are as 4 : 3 : 2. Thus the flame develops twice as fast at 800 r.p.m. and more than 1½ times as fast at 600 r.p.m. as at 400 r.p.m. Whether the speed of combustion is proportional to the speed of revolution, as it appears to be, *i.e.*, whether for speeds so different as 400 and 800 r.p.m., the same amount of fuel is burned in the same crank angle, is still open. This question is well worthy of investigation, since, if this is the case, this type of engine could develop much higher speeds. The author found nothing to indicate the contrary. The test engine ran at speeds from 200 to 800 r.p.m. smoothly, and with a clear exhaust from no load to full load. On the assumption of the combustion rate being proportional to speed of revolution, the maximum possible load with clear exhaust should be practically the same at all speeds. The tests showed the following results:—

Speed, r.p.m.	200	400	600	800
Mean indicated pressure, lb. per sq. in.	97	101	93	91

These differences are really small, and the efficiency of combustion, as shown by the fuel consumptions at all loads over this range of speed, is also remarkably consistent.†

For the combustion to be more rapid, it is necessary for the velocity of the air from *a* to *c* to be higher. That this is so is shown by the pressure tests. These are, however, limited to the compression stroke, since the vibrations of the testing diaphragm near top dead centre, made later readings unreliable. At 20 deg. before top dead centre the following excess pressures in *a* over those in *c* were found at different speeds:—

Speed, r.p.m.	200	300	540	800
Excess of pressure in *a* over *c*, lb. per sq. in.	3	4	11	25

Assuming that the velocity of flow is proportional to the square root of the pressure difference, the following results are obtained:—

Ratio of speeds of revolution	0·25	0·38	0·68	1·0
Ratio of velocities	0·34	0·4	0·68	1·0

The automatic adjustment of the rate of combustion to the speed of the engine is thus explained by the fact that the rate of flow of the air is almost directly proportional to the revolutions per minute of the engine. The engine thus gives that flexibility essential for use in an automobile.

To obtain a value for the velocity of flow, it may be assumed that at 800 r.p.m. and at 20 deg. after top dead centre the excess pressure is 17 lb. per square inch, a probable value. At a gas temperature of 700 deg. Cent., and under stable conditions, the velocity would be 500ft. per second; the corresponding velocity at 300 r.p.m. would be $0{\cdot}4 \times 500 = 200$ft. per second.

Special tests were run at light loads at 200 r.p.m. in order to reproduce "starting" conditions. The temperature readings as well as the fuel consumptions obtained show that even under these difficult circumstances the conditions for combustion remain favourable.

In addition to the great importance of the air velocity through *b* in connection with combustion in progress, it also exerts some influence upon the "self-ignition" of the fuel injected into the cylinder. This should take place while the piston is approaching the top dead centre, *i.e.*, while the pressure in *c* exceeds that in *a*. Under these circumstances, the flow is from *c* into *a*. The velocity is comparatively low at the entrance to *b*, but increases to a maximum at the orifice opening into *a*. The fuel is injected into these turbulent gases and encounters zones of increasing turbulence, a condition favourable for "self-ignition." There is an excess of fuel at first, which is consumed later as the air flow takes place from *a* to *c*.

The investigations upon the engine show that the Venturi-shaped portion is of great importance: ignition and the greater part of the combustion take place in it. The air necessary to maintain combustion passes from *a*, the storage chamber, to the Venturi, the hot gases passing away into *c*. The restriction of the combustion to a small part of the compression space results in a clear separation, during the process, between the new air and the exhaust gases, and thus a high temperature of combustion may be reached. This restriction of the combustion and the adjustment of the air flow to the engine speed are the essential characteristics of this type of engine. Its adaptability for high speeds of revolution and its suitability for automobile work follow from them.

In conclusion, Professor Stribeck remarked that little could be said at present on the relative volumes and shapes of the three parts of the compression space. At top dead centre space *c* is of no importance as an air space, and its shape is unfavourable to use as a combustion space. Since the combustion begins before top dead centre, this space is needed to accommodate the exhaust gases. The venturi space need not be large; its shape and the best size of its orifice can as yet only be found by experiment. The greater part of the air for combustion is stored in *a*, the volume of which depends upon the compression ratio required. For higher speeds the degree of compression should be greater rather than smaller.

† In justice to the engine, it should be stated that at the time the tests were made no attempt had been made to set the fuel pump and valve to give highest output and lowest consumption.

SIXTY YEARS AGO.

THE great international exhibition held at Paris in 1867 provided an opportunity for the close study of French and continental products and methods of manufacture, and for a comparison of our industrial position generally with that attained by our neighbours. There is considerable evidence in our pages of that date that the comparisons drawn were not always favourable to this country. The Institution of Mechanical Engineers had gone to Paris for its summer meeting, the first occasion on which any British scientific body had held a meeting abroad. The Institution met at the Conservatoire Impérial des Arts et Métiers in Paris, and in our issue of June 7th, 1867, we used the opportunity to give some particulars of the history and activities of that establishment and to express our sorrow that there was no similar establishment in this country. The Conservatoire had been founded in 1775 as a collection of models and samples for the instruction of the working classes, and in 1806 a mechanical school had been established in connection with it. At the date at which we wrote the Conservatoire, under the able direction of General Morin, possessed galleries containing 7000 models and specimens, owned a library of 17,000 books, and retained the services as professors of sixteen of the ablest men of the day. In this country the British Museum did not cater for mechanical science, and the Patent Office archives were a by-word for inefficiency. We regretted the absence in this country of facilities comparable with those provided by the Conservatoire on the ground that such absence led to redundancy of invention or a waste of time on the development of ideas that had already been tried and found wanting. The people of this country, we held, possessed a superabundance of practical mechanical talent, and were born with an intuitive sense of the eternal fitness of things in all that concerned machinery, but they were apt to despise the application of science to art, and, as a consequence, frequently went many wrong ways before arriving at the right one. In the same issue our commissioner at the Paris Exhibition had much to say on the same subject. The days were gone, he said, when the British workman could rely on the superiority of his craftsmanship. The exhibits at Paris showed that in that respect his continental brethren had become at least his equals. He pictured the British workman of the time as a muscular, heavy eating, heavy drinking, good natured individual, skilful in his particular occupation but ignorant and lacking in initiative outside it. His continental rival, our Commissioner wrote, had become his equal in skill and was not his inferior in physique. In addition, he had acquired a knowledge of the fundamental facts governing his work which the British worker would have held to be unnecessary and had attained to a degree of general education which the British worker would have despised.

BOOKS RECEIVED.

Marine Diesel Engines. By W. C. MacGibbon. Glasgow: James Munro and Co., Ltd.

Helium in Canada. By R. T. Elworthy. Ottawa: Mines Branch, Department of Mines. Price 20 cents net.

Carbon Brushes and Brush Shunts. Washington: United States Department of Commerce. Price 5 cents net.

Grundlagen des Aufzugsbaues. By Dr. M. Paetzold. Berlin: Julius Springer, Linkstrasse 23, W. 9. Price 20 marks.

Journal of the Franklin Institute. May, 1927. Philadelphia: The Franklin Institute of the State of Pennsylvania.

Ist Gussbeton wirtschaftlich? By Dr.-Ing. L. Baumeister. Berlin: Julius Springer, Linkstrasse 23–24, W. 9. Price 7.50 marks.

Modern Ignition. By H. H. U. Cross. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 4s. net.

Towards Industrial Recovery. By Hugh Quigley. London: Methuen and Co., Ltd., 36, Essex-street, W.C. 2. Price 4s. 6d. net.

Bulletin of the Imperial Institute. Vol. XXV. No. 1, 1927. London: John Murray, Albemarle-street, W. Price 3s. 6d. net.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. Avril, 1927. Paris, 6e: Siège de la Société, 44, Rue de Rennes.

The Magneto Manual. By H. R. Langman. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 7s. 6d. net.

Domestic Electric Heating. By H. G. Solomon. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 3s. 6d. net.

Report on the Science Museum for the Year 1926. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 1s. net.

Dredging and Dredging Appliances. By P. M. Dekker. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 36s. net.

Draft and Capacity of Chimneys. By J. G. Mingle. New York: D. Van Nostrand Company, 8, Warren-street, U.S.A. Price 3·50 dollars net.

A Manual of Automatic Telephony. By C. W. Wilman. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 7s. 6d. net.

Wärmetechnische Grundlagen der Industrieöfen. By Professor Hans v. Jüptner. Leipzig: Otto Spamer, Heinrichstrasse 9. Price 20 marks.

Indian Railways: Rates and Regulations. By N. B. Mehta. London: P. S. King and Son, Ltd., 14, Great Smith-street, S.W. 1. Price 10s. 6d. net.

Plastering, Plain and Decorative. Fourth edition. By W. Millar and G. P. Bankart. London: B. T. Batsford, 94, High Holborn, W.C. 1. Price 30s. net.

The Elements of Specification Writing. Third edition. By R. S. Kirby. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 10s. net.

The Metallurgists' Manual. By T. G. Bamford and H. Harris. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 15s. net.

Coal Carbonisation: High and Low Temperature. By J. Roberts. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 25s. net.

Theory of Machines. By Louis Toft, M.Sc., and A. J. J. Kersey, A.R.C.Sc., &c. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 12s. 6d. net.

Catalogue of the Collections in the Science Museum: Electrical Engineering. Compiled by F. St. A. Hartley. London: Adastral House, Kingsway, W.C. 2. Price 1s. 6d. net.

The China Architects' and Builders' Compendium. Edited by J. T. W. Brooke and R. W. Davis. Shanghai: The China Architects and Builders' Compendium, 17, The Bund. Price 10s. net.

Carbon y Fierro, No. I.: Decretos, Informes, Oficios, Resoluciones, Proyectos de Ley y otros Documentos Oficiales. (Ministerio de Fomento Comision Carbonera y siderurgica Nacional.) Lima: Imp. Torres Aguirre. 1926.

Engine Service Tests of Internal Combustion Engine Lubricating Oils made from California Crude Petroleum. By M. J. Gavin and G. Wade. Washington: Bureau of Mines, Department of Commerce. Price 15 cents net.

Kelly's Directory of the Merchants, Manufacturers and Shippers of the World. 1927. Two volumes. Vol. I.: Foreign Countries and their Possessions. Vol. II.: Great Britain, India and the British Dominions. London: Kelly's Directories, Ltd., 186, Strand, W.C. 2. Price 64s. net.

A New Wireless Receiver.

WITH a view to meeting the growing demand for a dependable wireless instrument for the interception of the long-distance Press messages daily transmitted by wireless from the principal high-power stations, a new wireless receiver has recently been developed in the laboratories of the Marconi Company. With the aid of a calibration chart, the receiver can readily be tuned to any particular station, the calibrated handle of each tuning circuit enabling the instrument to be instantaneously set to the required wave length, with the result that the instrument can be used by any telegraph operator who may be quite unskilled in wireless reception. The most important wireless stations transmitting Press messages work on wave lengths between 10,000 and 25,000 metres, and these stations have been erected by various Governments for the purpose of broadcasting official news bulletins and commercial information to their respective Dominions and Colonies overseas.

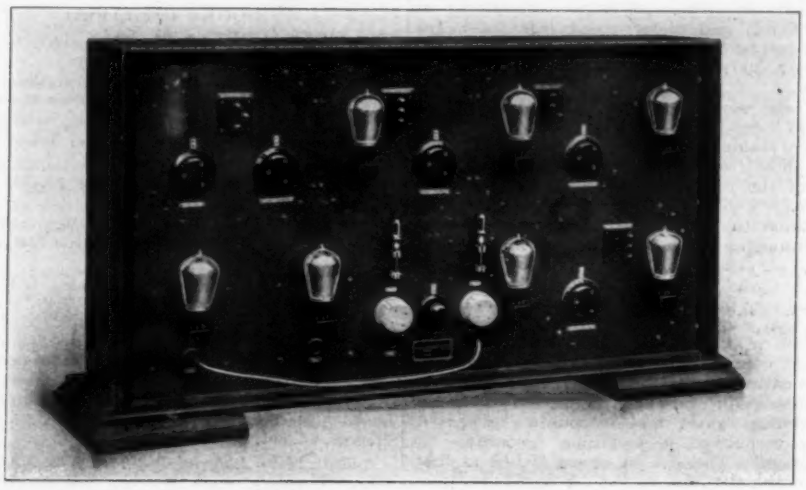


FIG. 1—MARCONI TYPE R.g. 12 "PRESS" WIRELESS RECEIVER

Quite apart from any reason of sentiment, a service which enables important items of national and commercial intelligence to be picked up daily in any part of the world should be of value to all industries, and particularly to those which are otherwise cut off from the main centres of civilisation.

It is, however, a fallacy to suppose that almost any receiver with a suitable number of valves and the required degree of sensitivity is capable of intercepting the wireless messages transmitted from the high power stations. Although it is frequently stated that these messages are picked up in remote places with very simple apparatus, the real difficulty of the problem does not become apparent until an attempt is made to pick up and intercept these messages regularly at predetermined times each and every day of the year. Obviously, the readibility of a signal does not depend so much upon its actual strength as upon its strength relatively to that of the interference which may originate from other transmitting stations working on approximately the same wave length or from atmospherics or local sources of electric radiation. The number of stations working simultaneously in different parts of the world has increased rapidly, with the result that wave lengths allocated to various transmitting stations have been crowded more and more closely together, to make room for the additional services in operation all over the world, the result being that the problem of selecting any particular station at the receiver has rapidly become more and more difficult. It is only necessary to "listen in" with an ordinary long wave receiver during one of the more crowded periods of the day, when most of the high-power stations happen to be transmitting their programmes, to realise the difficulty of trying to receive intelligible signals from one or more distant and comparatively weak stations. The criterion of a good receiver, therefore, lies not so much in its ability to receive signals, as in its ability to tune out other signals that are not wanted, and as it frequently happens that, owing to the greater proximity of the interfering station, the signals that are not wanted are many hundreds of times stronger than the signals which are required, the problem of reception and elimination can only be solved by the most perfect technical arrangements in the receiver itself.

The selectivity of the new receiver under consideration—type R.g. 12—is said to be such that two stations of equal strength and lying in the same direction can be separated if their frequencies differ from each other by only 120 cycles per second. The narrow difference in wave length which corresponds to this difference in frequency will be better appreciated from the following examples:—

Wave length.	Frequency.
10,000 m.	30,000 cycles
10,040 m.	29,880 ,,
20,000 m.	15,000 ,,
20,160 m.	14,880 ,,

It will thus be seen that at 10,000 m. the receiver can select between two stations only 40 m. apart, whilst at 20,000 m. the receiver can select between two stations only 160 m. apart. The receivers employed at any of the modern commercial service wireless stations are of an extremely elaborate character, but experience has shown that the heavy expenditure involved in the construction of such apparatus is abundantly justified by the improved performance of the apparatus, and, although the instrument under consideration is far less elaborate and less costly than those developed for high-speed commercial traffic, its design is based on the knowledge and experience gained in the development of the more elaborate receivers. In a modified degree it makes use of all the ideal methods of interference elimination embodied in the commercial receivers mentioned.

The three principal methods by which selectivity is secured are directional selection, high frequency selection, and low frequency selection. In this new receiver, directional selection is obtained by the use of a frame aerial from which the vertical components that tend partially to destroy its directional properties, have been carefully balanced out, thereby providing for what is known as the pure figure of eight polar diagram, as illustrated in Fig. 2. In this figure, O is the centre of reception and X X the direction in which the frame aerial lies, and it can be set to any required orientation. The length of the lines O Y, *i.e.*, from the point O to the periphery of the polar diagram, indicates the relative sensitivity of the receiver to signals coming from that particular direction. Thus, in the direction of O A and O B the sensitivity is actually zero, and within the angle θ the sensitivity can be taken as almost zero. The diagram, Fig. 3, relates to an open type aerial, O being the centre of reception. The length of the lines O A, O B, &c., from the point O to the periphery of the circle indicates the relative sensitivity of the receiver to signals coming from that particular direction, when using an open aerial, and it will be seen that the receiver then has equal sensitivity in all directions. The heart-shape diagram obtained with frame and open aerials is shown in Fig. 4, where O is again the centre of reception and X X the direction in which the frame aerial lies. The length of the lines O E, O F, O G from the point O to the periphery of the heart-shape figure indicates the relative sensitivity of the receiver in that particular direction when the figure-of-eight diagram—Fig. 2—is superimposed on the circle diagram—Fig. 3—and it will be seen that in the direction O F the sensitivity of the receiver is increased two-fold, and that the angle of approximate zero sensitivity is represented by the angle A O B.

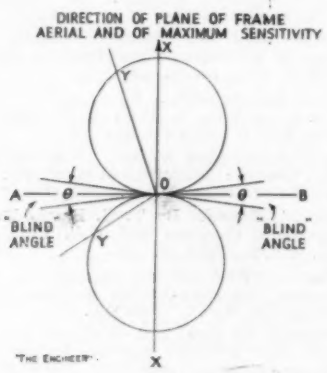


FIG. 2

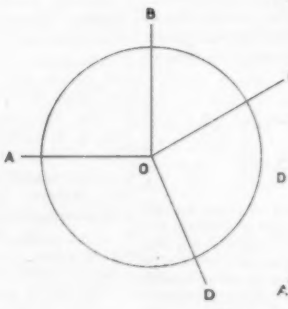


FIG. 3

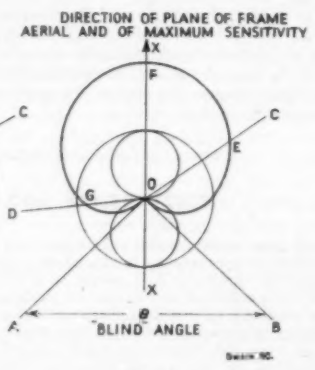


FIG. 4

By means of the phasing unit—shown in Fig. 5—the circular polar diagram obtainable with an ordinary open aerial, which gives uniform sensitivity in all directions as illustrated in Fig. 3, can be superimposed with the correct phasing on the figure-of-eight diagram to provide for reception of what is known as the heart-shape or cardioid polar diagram, shown in Fig. 4. Which of the diagrams is the most suitable to produce, depends upon the particular conditions prevailing at the moment, and can be chosen accordingly, a simple switch being embodied in the phasing unit, whereby either form of diagram can be utilised. In this receiver high-frequency selection is obtained by a series of low-damped and perfectly-balanced high-frequency circuits, each tuned to the particular wave length it is desired to receive, which collectively form a filter circuit, giving enormously increased selectivity over that of the individual circuits. The bottom bend system of rectification is also employed, because, no matter how strong an atmospheric may be, this system of rectification enables the receiving circuits to return instantly to their normal condition.

FIG. 5—PHASING UNIT

A local oscillator embodied in the receiver, and working in conjunction with the rectifier, reduces the frequency of the incoming signal to one of audio frequency, and it is then passed through a series of two-note filters designed to accept only that particular frequency to which the signal has been reduced by means of the local oscillator. This frequency depends, of course, upon the difference between the frequency of the incoming signal and that of the current generated by the local oscillator. Since a small change in the frequency of the incoming signal produces a large percentage change in the note frequency, any incoming signal differing slightly in wave length from that to which the receiver is tuned will be eliminated by the note frequency filters, which thereby add enormously to the selective properties of the receiver. Normally, the receiver is arranged for aural reception of telegraph signals, but by the use of additional apparatus it can be made to record signals, the audio frequency alternating-current signals delivered by the receiver being converted into direct-current signals for operating the recorder.

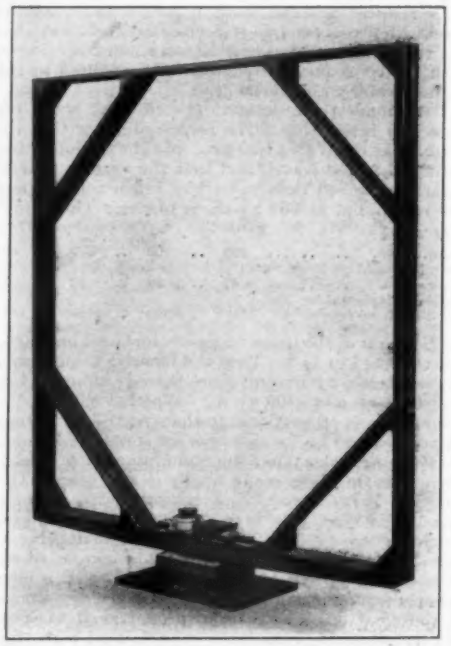


FIG. 6—FRAME AERIAL

The aerial system—see Fig. 6—consists of a 6ft. square frame, on the outside of which two multi-twin coils of insulated wire are wound, and for tuning purposes three fixed condensers and a variable condenser are mounted on the frame. Each or all of the fixed condensers can be connected across the variable condenser by means of plug connections. The high-frequency filter system comprises three valve-coupled tuning circuits of low damping. Each circuit contains a fixed inductance, three fixed condensers

—any one of which can be included in the circuit by means of a plug connector—and a variable condenser. The first high-frequency valve is coupled to the frame aerial by means of an adjustable coupling coil, and the third valve has a separate grid negative connection to enable it to be set at the rectifying point. Each circuit is enclosed in a separate screening box.

The local oscillation generator consists of a single oscillation valve with a tuning circuit, comprising a fixed inductance, a fixed coupling coil, three fixed condensers, any one of which can be included inthe circuit by means of a plug connector, and a variable condenser, the circuit being enclosed in a screening box. The low-frequency filter system comprises two valve-coupled tuning circuits, designed for a note frequency of 1200 cycles, each unit being mounted in a separate screening box, and by means of a plug and socket connection either or both note filters can be disconnected from the circuit. The note magnifier is a single-stage magnifier with transformer inter-valve coupling, and the input circuit of this note magnifier can be connected in the output circuit of the rectifier, or in the output circuit of either of the note filters, the output circuit of the magnifier being provided with a step-down transformer for low resistance telephones. When it is desired to use the heart-shaped polar diagram, the phasing unit and a 35ft. single-wire open aerial are required, the phasing unit consisting of a single valve with the grid connected to the open aerial. The anode circuit contains a rotable coil inductively coupled to two fixed coils, which are connected to the frame aerial and to the receiver. A small switch enables the valve to be switched on or off, thereby providing for heart-shape or figure-of-eight reception respectively.

Large Boring Machine for Turbine Cylinders.

In connection with the description of the Leipzig Fair which appeared in our issue of March 18th last, we made brief mention of an immense boring machine exhibited by Messrs. Schiess-Defries, of Düsseldorf. This machine was ordered by Brown, Boveri and Co., for the boring of large turbine cylinders at their works in Baden, a similar machine being also supplied to the new works of the American Brown, Boveri Company in Camden, New

TURBINE CYLINDER BORING MACHINE AT LEIPZIG FAIR

Jersey, where it will be used for the manufacture of the 160,000-kilowatt turbine now in course of construction there. The machine, as it appeared in the Machinery Hall at Leipzig, with the boring bar in position, is illustrated herewith, and on page 630 views are given showing the main standard and driving gear in more detail. Some idea of its magnitude will be gained from a comparison with the fencing of the stand on the engraving herewith, and with the men shown in the other engravings. The actual dimensions are given in the following table :—

Particulars of Boring Machine.

Maximum height of centre of boring bar above bed-plate	2,500 mm. (11ft. 5⅝in.)
Vertical travel of headstock	1,300 mm. (4ft. 3⅛in.)
Travel of standard along bed-plate	2,500 mm. (8ft. 2⅜in.)
Maximum diameter to be bored ..	4,000 mm. (13ft. 1⅜in.)
Maximum diameter to be faced ..	5,500 mm. (18ft. 2⅜in.)
Maximum diameter of boring bar ..	600 mm. (23·6in.)
Revolutions per minute of boring bar	0·3 to 30
Length of bed-plate	14,000 mm. (45ft. 11⅛in.)
Breadth of bed-plate over ways ..	8,000 mm. (26ft. 3in.)
Total length of boring bar	14,000 mm. (45ft. 11⅛in.)
Approximate horse-power required	50 to 55 (50 to 55)
Revolutions per minute of motors..	420 to 1260
Weight, including bed-plate	240,000 kilos. (236 tons)

With the machine were supplied boring bars of 200 mm., 250 mm., 400 mm. and 500 mm. diameter, and a boring head suitable for work from 600 mm. to 5000 mm. diameter. The driving power is furnished by a variable speed continuous-current motor built into position, and provided with push-button control. One control board is situated on the headstock and one on the standard beneath, while two are arranged with flexible cables, so that the operator can also control the machine from either side or even from a position inside the work itself. The motor is situated at the back of the standard and travels with it along the bed. The switchgear is arranged in a cupboard, also on the standard.

The motor drives the headstock through a change-speed gear, and vertical shaft. The boring bar is fastened to the face plate by a flange and travels axially with the standard as the latter moves along its bed, the work being stationary. The weight of the headstock is partially balanced by a counterweight, the chains supporting the latter being visible in the engravings. The vertical setting of the headstock is effected mechanically by both a coarse and fine traverse, but hand adjustment is also provided. For ease in making the adjustment of the bar, scales and verniers are fixed to the standard, these being arranged to correspond with similar items on the fixed columns. Similar coarse, fine and hand adjustments are provided for the traverse of the standard along the bed, the hand motion being easy in spite of the great weight to be moved. As a protection against over-running, besides mechanical safety couplings in the main drive and the feed motion, there are end stops, contact with which automatically cuts the current off the motor.

The drives for the quick traverses, feeds and reverse are situated in the foot of the standard, and the control hand wheels are all in easy reach of a man standing on the floor. The arrangement of interlocking prevents mistakes on the part of the operator which might damage the machine. Lubrication of all moving parts and also of the sliding ways of the bed is provided for by a central oil pump, with a sight control for every lubricating point. There are altogether eighty-five such points, each served by its independent oil pipe.

The boring bar supporting columns can be placed in any position axially along the bed. The steadies which carry the bar are capable of vertical and horizontal adjustment, the vertical motion being provided by special motors mounted in the columns. The boring bars are slotted to receive tools for work of a diameter slightly greater than that of the bars, and are provided with special heads for larger work. For straightforward cylindrical boring, the heads are of comparatively simple construction, but in steam turbine work there is often a question of boring on a large number of diameters, of boring conically, or of cutting T-shaped slots in the casing. To avoid the changing of boring heads for different classes of work, Messrs. Schiess-Defries designed a universal boring head for the machine in question. For plain cylinder boring the tool holders are locked to give the right diameter, and the head is then fed through the work by the motion of the standard of the machine. For boring conically, the tool holders have to be moved radially as the head moves along, while for facing the head has no axial movement, but the tools move radially outwards. The radial motion is obtained by a star-wheel mechanism, and by the use of change wheels conical work, ranging from a taper of 1 in 30 to 1 in 2 can be machined. It may be mentioned that the high and low-pressure casings for the 160,000-kilowatt turbine, which will be bored on the machine described, weigh respectively 45 tons and 340 tons.

For the purpose of testing the effectiveness of various stone preservatives, some experiments are being carried out by a special committee of the Department of Scientific and Industrial Research. The following solutions have been applied to the test piers :—(*a*) Paraffin wax (M.P. 105 deg. Fah., made up to a 2½ per cent. solution in ligroin of boiling range 85-115 deg. Cent.); (*b*) sodium silicate (Brunner, Mond's P. 84, made up to a 2 per cent. solution in water); (*c*) saturated baryta water, followed by an 8·6 per cent. solution of hydrated aluminium sulphate followed by a second application of saturated baryta; (*d*) saturated baryta water, followed by a 3·7 per cent. solution of arsenic acid, followed by a second application of saturated baryta water; (*e*) silicon ester in alcoholic solution—as supplied by the manufacturers; and (*f*) zinc magnesium silicofluoride, made up to a 5 per cent. solution in water. (In the case of the sandstones, this solution was preceded by a coat of saturated limewater). The piers received their first treatment in the summer of 1926. Three successive coats of all the solutions have been applied at twenty-four hour intervals between each coat. The piers are to be inspected periodically.

High Steam Pressure and Temperature at Crawford Avenue Station.*

By ALEX. D. BAILEY, Superintendent, Generating Stations, Commonwealth Edison Company, Chicago, Ill.

WHEN the Commonwealth Electric Company started to build its Fisk-street station nearly twenty-five years ago a radical step was taken which caused many to shake their heads with doubt and misgiving for the success of the undertaking; but out of the grief and trouble of that installation was born the present central station with its large prime movers, which is to-day the foundation of central station service and electric utility development. The men who built the Fisk-street plant had the courage of their convictions to attempt a prodigious installation with steam turbines, a new type of prime mover; but ten years before this inception Harrison-street station had been started with much higher steam pressure than was then in common practice. In this installation the individual units were high-speed, triple-expansion engines with direct-connected generators, large units for their time.

(2) Needless to say, both jobs presented their full quota of problems when they were started up, but out of the worry and heat and sweat and dirt there emerged in each case a power station justifying the dreams of its originators and designers, a credit to them and the profession they represented.

(3) Crawford-avenue station is the last undertaking of the Commonwealth Edison Company, and involves a rather radical change in operating conditions. This time the step was again in the direction of higher steam pressure as well as temperature. As was the case at the Harrison-street and Fisk-street stations, this was no small experimental installation, but one of such magnitude that it formed the backbone of one of the greatest utility systems in the country. On it depends the service of a great public utility. It was a ground-hog case; it had to perform.

(4) As in the past, new problems had to be met and solved after the equipment was started, but before the kinks could be worked out of the initial installation of 160,000 kW load conditions demanded that additional equipment be provided to take care of load increases, and plans were made and equipment purchased for additional capacity equal to the original installation.

(5) A steam pressure of 550 lb. and a temperature of 725 deg. Fah. looked like a real problem, but the preliminary studies and experience of the engineers, the operators and the manufacturers eliminated many of the difficulties in advance, and most of the real problems of the installation have been occasioned by conditions entirely outside the questions of pressure and temperature. High capacity, which is more and more demanded by economic necessity and which is a measure of our ability to speed up the almighty dollar and make it produce more in a given time, has been responsible for more troubles than pressure and temperature combined. When to this is added the devilish characteristics of the fuel which is used, the question of pressure and temperature sinks into the background. Most of the problems are no greater than those encountered with lower pressures and temperatures; in fact, they are in general the same.

(6) Higher steam pressure and temperature were attempted primarily, of course, to get the benefit of the greater heat range, although it also afforded greater opportunity for bleeding as well as reheating. Increase in the size of generating units followed, although this may not be directly credited to higher pressure and temperature. As compared with the company's most recent previous installation, Calumet station, the increase in steam pressure meant a saving of over 5 per cent., while the increase in temperature was good for nearly 2½ per cent. more—a total of over 7½ per cent. The saving due to reheat was about 5½ per cent., and the additional bleeding 2½ per cent. In a station the size of Crawford-avenue, which this year will consume 95,000 tons of coal in a single month at a cost of over 350,000·00 dollars, this is worth while. The study of the thermodynamic advantages of higher pressure and temperature has been gone over so many times in the last few years and the matter has been so completely explained and is now so generally understood that a repetition is not necessary for this discussion.

(7) The next question naturally follows—If such gains were possible with 550 lb. pressure and 725 deg. temperature, why were not still higher pressure and temperature gone to? The answer can be readily given. At the time of the inception of Crawford-avenue station, 600 lb. or 650 lb. was the limit for riveted drums and for the standard types of boilers. The turbine manufacturers did not care to consider higher pressures for units of the size contemplated. Furthermore, the properties of steam at pressures above 600 lb. were not definitely proven, and the figures for the higher range were more or less hypothetical. All things considered, 550 lb. at the turbine and 650 lb. at the boiler seemed the logical safe limit for this installation.

(8) As for temperature, everyone agreed and still agrees that 725 deg., or possibly 750 deg., is the safe limit of temperature for the metals which are available for this type of equipment. While reports would indicate that somewhat higher temperatures are being used in central stations in Europe, it seems to be the opinion here that we have reached the safe limit of temperature, at least for large base-load installations. All the studies of the available metals at high temperature have strengthened this conviction.

(9) In passing, it should be noted, however, that the parts subjected to this extremely high temperature are few in number and relatively small in extent, and it is probable that our old friend, economic necessity, will cause metals to be developed which will enable us to get the benefit of the high efficiencies possible with higher temperature.

(10) It might be expected that the changes described and the additional equipment required would increase unit investment costs considerably, but the contrary was true, although the reduction was primarily due to increased capacity of boilers and turbines. Since the two stations are owned by the same company, and the standard of

* Read before the American Society of Mechanical Engineers at White Sulphur Springs on May 23rd, 1927.

design and construction is the same in both, comparisons can be safely made. Investment costs in dollars per kW installed are as follows :—

	Calumet.	Crawford Units 1–2–3.	Crawford Unit 4.
Turbine equipment ..	27·46	29·38	23·33
Boiler equipment	40·00	43·25	32·13
Building	34·21	30·20	

Performance of Equipment.

(11) So far as the performance of the generating units is concerned, Fig. 1 shows a typical performance curve for the first three units. As these three machines were designed for approximately the same operating conditions and are quite similar so far as reheat, bleeding, &c., are concerned, a typical curve may be used for the three, both with and without reheat, in order to compare this type of turbine with the Calumet units and with the next unit installed, which is not equipped with reheat. These units have met the guarantees and have justified the expectations of the manufacturers and the engineers.

(12) There have, of course, been some turbine troubles, large and small, but relatively few were due to pressure and temperature. The turbine units have performed most creditably. Only one case of trouble can in any way be attributed to high temperature, and this the manufacturer remedied promptly and effectively. Blades, wheels, packings, casings, &c., subjected to high pressure and temperature, have given no cause for worry whatever, due primarily to improvements in design. These casings have been tighter than some of the old 200 lb. installations.

(13) Because of the prospect of the State Line Station, which it was anticipated would contain exceedingly large

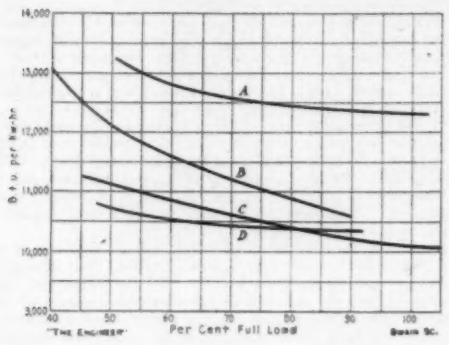


FIG. 1—Turbine Performance, Calumet and Crawford Avenue Stations. Heat Consumption

A—Calumet, units Nos. 1 to 6; B—Crawford-avenue, units Nos. 1 to 3, without reheating; C—Crawford-avenue, units Nos. 1 to 3, with reheating; D—Crawford-avenue, unit No. 4, no reheating.

units and would carry base load, it was anticipated that the first three units at Crawford-avenue would take care of base load at this station for some time to come. When unit No. 4 was specified, therefore, it was purchased with the understanding that its load factor would not be so good as that of the previous units; that it would probably be shut down every night, and that its load during the greater part of the time would be at some point below the maximum, in order to have this unit carry a part of the system reserve. The characteristics of this unit are therefore entirely different from those of the first three. The expense for the reheat installation applied to the first three could not be justified, and an effort was made to obtain the greatest capacity possible in the space allowed; also, to simplify the equipment as much as possible, so that variations in load could be readily taken care of. The manufacturer was asked to provide a turbine unit which could be readily started and shut down without danger of mechanical trouble.

(14) Before this unit was installed, a method of reheating was devised which, while it did not give the amount of reheat provided in the original installation, afforded a limited amount at a greatly reduced cost. This installation, which is being applied to unit No. 5 now under construction, consists of a reheater between the two elements of the turbine in which the steam passing from the high

Calumet Conditions.

	Units Nos. 1 and 6.	Units Nos. 2 to 5.
Initial pressure, lb. per sq. in.	300	300
Initial superheat, deg. Fah.	225	228
Vacuum, inches Hg.	1	1

Crawford-avenue Conditions.

	Units Nos. 1	2	3	4
Initial pressure, lb. per sq. in.	550	550	550	550
Initial superheat, deg. Fah. ..	270	245	245	270
Vacuum, inches Hg.	1	1	1	1
Reheat temperature, deg. Fah.	700	725	700	—

to the low-pressure turbine is heated by live steam. This can be justified by the possible saving, even at reduced load factors.

(15) This subject of reheating, which in the original installation was a boiler-room problem rather than one for the turbine-room, was most interesting, and the problem presented was one which was susceptible of easy solution. Fig. 2 shows the relation of fixed charges on both types of reheating equipment with relation to load factor and to savings effected. Although the saving with the steam reheater is only 3 per cent., as compared with 5½ per cent. for the boiler reheater, its cost is so much less that the advisability of its installation is obvious. In addition, the building space requirements are much greater for the boiler reheater, and the maintenance cost will doubtless be greater.

(16) The vertical condensers with the tubes rolled into the tube sheet at one end and packed at the other have worked very well indeed. The circulating water at Crawford-avenue is exceedingly bad, as it contains not only sewage and dirt, but has a great amount of organic matter which congeals on being heated, and which most effectively blocks off the tubes. The company has been experimenting with chlorine treatment of the water going to one of the generator air coolers, and with the co-operation of the manufacturers of chlorine treatment apparatus has obtained results quite encouraging. Although previous tests with chlorine on one of the condensers at North-West Station three years ago did not justify this system of treatment, it is possible that the extreme conditions at Crawford-avenue will justify some such means of keeping the condenser surfaces clean. It is known that chlorine treatment will prevent or at least retard the formation of slime in the tubes and on the tube sheets.

(17) As for tightness, these condensers have given better results than any previous installation. Leakage has been

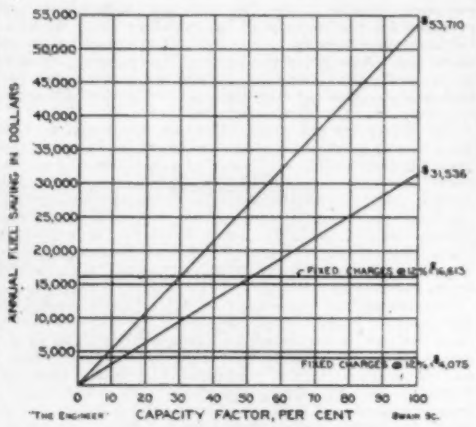


FIG. 2—Relation between Capacity Factor, Fixed Charges and Annual Fuel Saving by Different Methods of Re-heating Steam at Crawford Avenue Station

reduced to a minimum, and with little effort or expense. The rolled joints have given no trouble whatever, and the various types of tube packing used have all been effective. The cleaning of condensers because of bad water conditions is the only problem so far as this equipment is concerned.

(18) The boiler-feed pumps are a part of the equipment with which very little, if any, trouble was expected. On the contrary, considerable work was necessary with the high-speed steam-driven pumps, to make them perform satisfactorily. The motor-driven pumps are a new development, being four-stage 3600 r.p.m. pumps with split cases. There was some trouble with these, due to leakage between stages, thrust bearing troubles, &c., which were soon remedied, and the pumps have since given no trouble whatever. However, a six-stage 1800 r.p.m. pump has been resorted to for this service on the fourth and fifth units. The water supply to these pumps is pumped from the condensers through the bleeder heaters directly to the pump suction, and a pressure of about 20 lb. maintained at this point. Any excess is discharged to the make up water reservoir, and any shortage is made up in the condenser hot well from this source.

(19) In the original installation the turbines were bled at three points, while unit No. 4 was bled at four. Packing

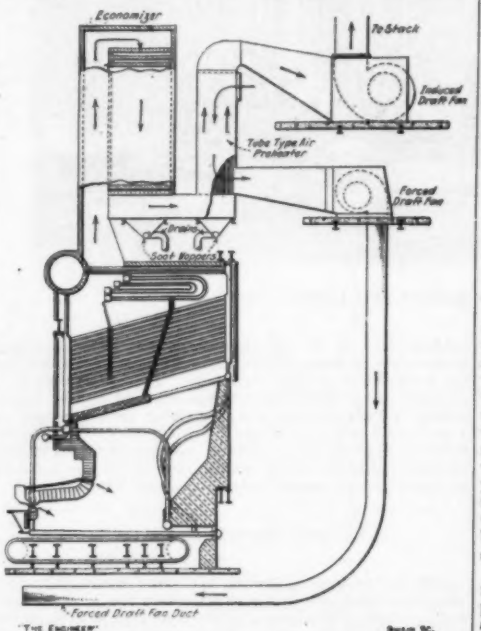


FIG. 3—General Arrangement, Boiler No. 16, Calumet Station

failures in the bleeder heaters were numerous and troublesome at the start, and heater leaks were the order of the day. A moulded asbestos packing has been found which has eliminated this difficulty, and heater troubles seem to be a thing of the past. This cannot be charged to high pressure or temperature, however, as the pressures encountered are at the most only moderate and generally low. There was some slight trouble also due to improper venting, but this was soon taken care of.

(20) The piping which is subjected to high pressure and temperature has given little trouble so far as the joints are concerned. Sargol joints are used for all the larger pipe sizes in the steam lines, the joint being held by the flanges and the weld serving only as a seal. On the feed lines, recessed joints are used, made up with soft gaskets. Valves in general have been quite satisfactory. Defective steel castings, however, have caused no end of trouble, and there is yet to be found a line of fittings which will stand the service. Although these may be tight at first, leaks develop after relatively short service. While the X-ray method of testing might detect these faults, it has been considered impractical for an installation as large as Crawford-avenue, and no other system of testing has apparently been devised which will serve the purpose. Apparently so far as steel castings are concerned, conditions are very little better, if any, than they were when the station started.

(21) The pipe covering installed has given very satisfactory service, both from the standpoint of heat insulation and mechanical strength. This is the result of rather exhaustive tests of various kinds of covering over a period of a year or more.

Boiler-equipment Problems.

(22) It is in the boiler-room, where the greatest changes have been made because of the high pressure and temperature, and where the effect of the poor coal is noticeable, that most of the real problems have been presented. As attempts are made to make the boilers and furnaces more efficient by increasing furnace temperatures and reducing stack temperatures, the destructive characteristics of the fuel are met at every turn. The analysis of this coal is as follows :—

	Per cent.
Moisture	14·50
Ash	12·71
C	54·59
H	4·00
S	3·86
N	·87
O	9·47
B.Th.U.	10,255

Heating Surfaces.

Boiler, square feet	16,600
Superheater, square feet	3,100
Economiser, square feet	7,376
Air preheater, square feet	15,913
Water-cooled walls, square feet—	
Side	834
Front	837
Rear	844

Miscellaneous.

Effective grate area, square feet	444
Total combustion chamber volume, cubic feet	5,750
Superheater tube diameter, inches	2
Economiser tube diameter, inches	2

(23) The ash has a fusion temperature of 2000 deg. or less, there is a lot of it, sulphur is everywhere, at least its effects are, and the excessive moisture, to say nothing

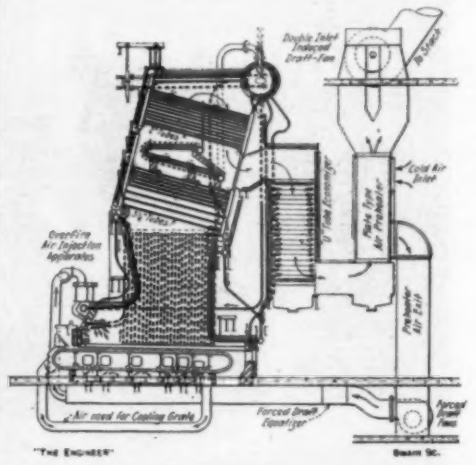


FIG. 4—General Arrangement, Boiler No. 5, Unit No. 4, Crawford Avenue Station

of the hydrogen, causes high moisture losses in the stack gases.

(24) Cross sections of the boiler and furnace at Calumet and boiler and furnace at Crawford are shown in Figs. 3 and 4. In the Calumet boiler there is no water cooling surface in the furnace, with the exception of the bridge wall water back and water boxes at the base of the side walls to prevent slag from running down on to the grates, and to eliminate the slicing of fires, which is so common with the older installations. As an experiment, the installation of a limited amount of cooling surface in the walls of one of the Calumet furnaces was tried about three years ago, and the operation of this addition was so satisfactory and the protection afforded the refractory side walls was so effective that, beginning with two of the boilers of unit No. 3 at Crawford-avenue station, all the subsequent furnace installations are water cooled.

(25) So far as furnace efficiency is concerned, the changes in boiler and furnace design have offered many interesting problems. The new type of boiler employed at Crawford-avenue is apparently a more efficient heat-absorbing machine than the 350 lb. boiler at Calumet—see Fig. 5. It has, however, been rather definitely determined that there is a limit to the amount of water-cooled surface which can be installed in the furnace walls. If this is overdone the ignition of the coal is retarded and the final burning out of the coal is delayed. The boiler equipped with a refractory lined furnace apparently gives the best efficiency, but in order to maintain the high capacities necessary the maintenance of the refractory lining would be excessive and the furnace could not be operated continuously for sufficiently long periods. It is evident, therefore, that a compromise will have to be made, and a furnace enclosed on three sides with water tubes alternated with rows of refractory and with a refractory arch will probably be not only the cheapest to install but the most efficient. None of these water-cooled furnaces have given any trouble whatever.

(26) So far as feed water conditions are concerned, the make-up was originally treated in Zeolite softeners, sul-

phuric acid being added to maintain the proper sulphate-carbonate ratio in the boiler water. With the boilers operating at high capacity dirt was carried over into the steam lines and into the turbines, where it was deposited on the turbine screens and in the initial nozzles and blades. An evaporator has recently been installed, in which all the make-up will be treated and the concentration of the boiler water thus reduced. It is hoped that this will eliminate the trouble referred to. Just how this dirt is carried over has not been definitely decided—whether by water in the steam or in the form of dry dust. Everyone seems to agree, however, that the possibility of foaming is reduced rather than increased by the higher steam pressure.

(27) The boilers have given a good account of themselves. Some trouble with hand-hole gaskets was soon taken care of and eliminated. There has always been considerable trouble from slag which is carried up with the gases and lodged between the tubes, and the conditions in this regard were worse with the Crawford-avenue boilers than with previous installations, due to reduced tube spacing and higher capacity. As this accumulation

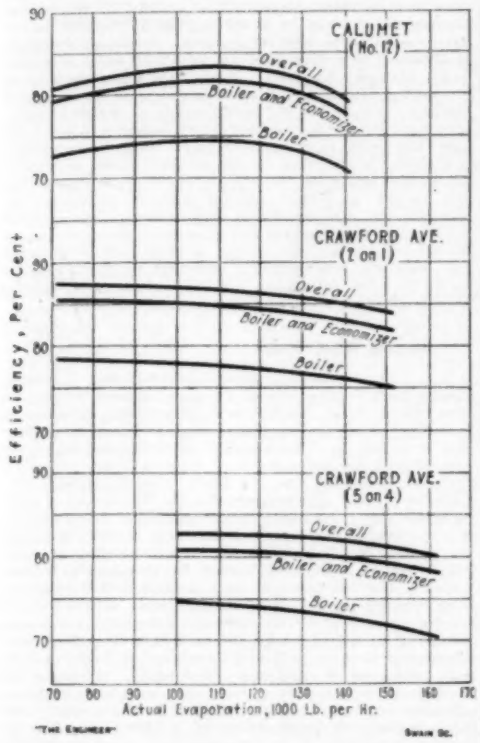


FIG. 5 Boiler Performances, Calumet and Crawford Avenue Stations

could not be blown off with steam, attempts were made to crack it off with a fine water jet. It was found, however, that this loosened the tubes in the rolled joints, so it was necessary to rely on steam blowers for cleaning.

(28) The auxiliary equipment on the boilers has also given little trouble. Safety valves, which it was anticipated would be very annoying, have performed, as they do occasionally, very creditably. This has been a very agreeable disappointment, although a decrease in the amount of blow down required would be appreciated. Feed water regulators have gone along fairly well, although their work has been reduced by the installation of differential pressure regulators ahead of them in the feed line to each boiler. With increasing capacity a variable differential pressure regulator will be required to take care of this job satisfactorily.

(29) In order to guard against excessively high steam temperatures the superheater surface in the boilers was restricted more than was later found necessary. This, together with the fouling of the tubes externally, resulted in temperatures somewhat below that specified, but additional surface is being added which will take care of this deficiency. This is being taken care of in advance on the equipment now being installed. Superheater troubles have been due apparently to poor circulation, rather than to dirty steam and imperfect gas distribution.

(30) In the first three units there was originally considerable burning of the superheater tubes, particularly in the reheat boilers where the amount of steam was reduced. Very seldom, if ever, was any deposit found in the tubes in these cases. The installation of steam baffles in the superheater boxes is helping this situation both in the original installation and the new. The tubes being installed in the new equipment are of Enduro metal.

(31) The reheat boilers have probably been the greatest surprise of the installation. Before they were put into service these were looked upon with considerable awe, and all manner of prophecies were made as to what would happen in case the turbine lost its load or in case of sudden variations in load. None of these anticipated troubles have developed, and it has been found that the reheat boiler can be operated with the steam temperature as a guide. The reheater part of this installation has given no trouble whatever. Not only has there been no difficulty in cutting in and cutting out this piece of equipment, but its continued operation has offered no new problems. As was the case with superheaters, the manufacturers were apparently anxious to avoid overheating the steam in the reheaters between the high and low-pressure turbines, and this, combined with the superheater troubles previously mentioned, has resulted in the station operating with lower reheat than that designed. This deficiency, amounting to 50 deg. or more, seriously reduces the efficiency of this part of the steam cycle. The means for correcting this deficiency have not yet been determined.

(32) The greatest source of trouble in the boiler-room has been the economisers. Although there has always been considerable trouble and expense in maintaining economisers in the older stations where lower pressures are employed, the deluge of trouble encountered at Crawford-avenue was not anticipated. Although the temperature of the water entering the economisers and the temperature of the gas surrounding them are higher than in previous installations, the deterioration is much more rapid. Mechanical strains set up in the joints caused minute leakage which resulted in rapid deterioration due to the sulphur in the coal. Although this equipment at first gave no indication of trouble, it was only after one and one-half or two years of service that this leakage became so serious that it was impossible to keep the economisers in service.

(33) In order to avoid this on the fourth unit, a change was made in the design in that the boxes are eliminated at one end of the economiser, the tubes being bent in hair-pin form, the open ends being rolled into boxes similar to the previous installation. The final design which has been adopted for unit No. 5 and which is being used in replacing the economisers on the first three units, consists of straight tubes with return bends bolted on the ends. These tubes are supported in cast iron plates, the openings being packed so that the flue gas cannot get at the joints. It is, of course, anticipated that the natural external corrosion of the tubes due to the sulphur in the flue gas will continue, but this is such a slow process that the tubes should last for several years. In addition, this type of installation adapts itself to the use of enamelled tubes on which the manufacturers are diligently working at the present time. These types of economiser construction are shown in Fig. 6.

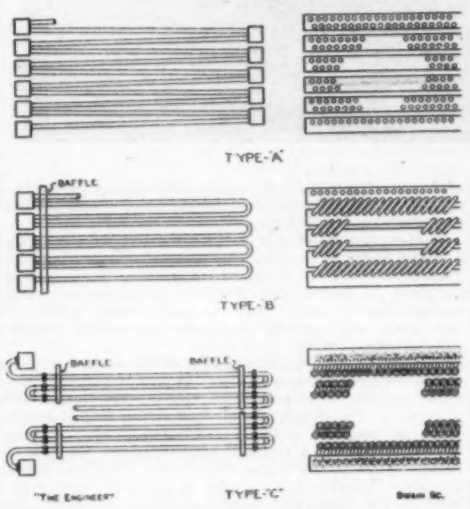


FIG. 6—Types of Economisers in Service at Crawford Avenue Station

(34) At the time this station was designed two air preheaters were in service at the Calumet station. These had been in operation only a short time, and due to previous experience with economisers it had been anticipated that the corrosion in the air preheaters would be very excessive. Accordingly, preheaters were installed only on No. 1 row of boilers at Crawford-avenue, where the feed water is supplied to the economisers at 300 deg. The preheaters at Calumet have shown little, if any, corrosion, but after some 2½ years of service those at Crawford-avenue show considerable corrosion. A good part of this is attributed to moisture coming over with the gas from leaking economisers. Consequently, the company is going ahead with the installation of preheaters on No. 2 and No. 3 units of boilers, and No. 4 unit is already equipped.

STOKER PROBLEMS.

(35) The subject of high preheat has introduced stoker problems which were not fully appreciated in advance. Although air heated to 180 deg. or 190 deg. had previously been employed, this was the first experience of the company with 300 deg. air under chain grate stokers. There was some trouble, due to heating of the chains, resulting in burning of links and uneven fires, but this is being remedied by cooling the chain on its return or by means of water-cooled drums at the rear of the stoker. It is anticipated that somewhat higher temperatures than those employed at present can be safely employed

CONCLUSIONS.

(36) In conclusion, let it be repeated that in general the problems at Crawford-avenue station have been the same old problems or have been similar to the problems encountered in the older stations of the company. Some bad conditions have been aggravated by the higher pressure and temperature, but generally there have been other contributing causes. No longer does the operating staff stand in awe of so-called high pressure, and it sees no reason why still higher pressures cannot be used if they prove economically advantageous. The design of steam generating equipment is undergoing many rapid changes and improvements, and more will doubtless be necessary before higher pressures will be generally adopted. Aside from the troubles with castings previously cited, piping should offer no serious problems. As for turbines, none of the manufacturers have said how far they are willing to go in size for pressures over 600 lb. As for higher temperature, this seems to be entirely a matter of metals, and materials for this service will have to be developed before there can be any material gain in this direction.

(37) It is generally agreed, however, that the gain resulting from increased pressure decreases as the pressure increases until the point is reached where the increase in fixed charges overcomes the savings effected in operation. The thing to be striven for in the utility business, at least, is the best possible service at the lowest possible cost, and this cost depends on investment costs as well as operating. High thermodynamic efficiency is only part of the story. From Fig. 7 it will be seen that under the conditions at Crawford-avenue the fixed charges per ton of coal burned per 100 dollars unit cost amounts to slightly more than 3 dollars at 60 per cent. capacity factor. This means that an increase of 10 per cent. in investment cost must effect a fuel saving of approximately 9 per cent. in operating cost in order to be justified, in fact to break even. One dollar added to the investment cost per kilowatt installed has the same effect as adding 3 cents per ton to the price of coal. Although this may be an old story, it will bear considerable study.

(38) In high capacity lies the hope for reduced invest-

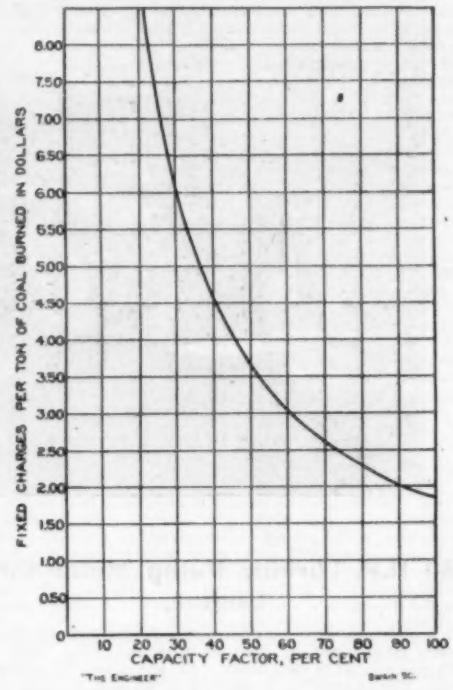


FIG. 7—Relation between Capacity Factor and Fixed Charges (at 12 per cent.) per Ton of Coal Burned for an Investment of 100 dollars per Kw., Crawford Avenue Station

ment cost. If higher steam pressure and temperature will help to accomplish this end, and give also additional operating efficiency, the way is clear. If, however, the two are opposed, then each problem will merit the most careful analysis with the emphasis always on the investment side of the argument.

THE INSTITUTE OF BRITISH FOUNDRYMEN.

THE annual convention of the Institute of British Foundrymen will be held at Sheffield from July 5th to 8th, inclusive. The following programme has been arranged :—

On Tuesday, July 5th, at 6 p.m., there will be a general Council meeting in the Cutlers' Hall, Church-street, Sheffield, which will be followed at 8 p.m. by a reception at the Cutlers' Hall, at the invitation of the Master and Mistress Cutler. On the Wednesday, at 9.30 a.m., the conference proper commences at the Applied Science Department of the University of Sheffield, St. George's-square, where the members will be welcomed by the Vice-Chancellor of the University, Sir Henry Hadow; the Lord Mayor, Alderman J. G. Graves; the Master Cutler, and the President of the Sheffield Chamber of Commerce, Mr. J. H. Chapman. In the afternoon, starting at 2.15 p.m., visits will be paid to the works of Edgar Allen and Co., Ltd., Cammell Laird and Co., Ltd., Newton, Chambers and Co., Ltd., and Vickers Ltd.

On the Thursday, at 9.30 a.m., the conference will be resumed at the University, St. George's-square, and will be continued till 4 p.m. At 4.30 p.m. there will be a civic reception at the Town Hall by the Lord Mayor and Lady Mayoress. On the Friday, starting at 9.30 a.m., visits will be paid to the Brown-Firth Research Laboratories and to the works of Darwins, Ltd., Davy Bros., Ltd., and Samuel Osborn and Co., Ltd. In the afternoon there will be a motor coach excursion to the Derbyshire Dales.

The papers to be considered at the conference are as follows :—(1) American Exchange paper: "The Properties of Coke Affecting the Cupola Melting of Steel," by Mr. J. T. MacKenzie, of the American Cast Iron Pipe Company, Birmingham, Alabama; (2) Belgian Exchange paper: "Some Methods of Making Steel Castings," by Monsieur Georges Fosseprez; (3) French Exchange paper: "The Making of Steam Engine Cylinders," by Monsieur Audo, Chief of Foundries of the Paris-Orleans Railway Company; (4) "The Influence of Chromium and Nickel on High-quality and Heat-treated Cast Irons," by Professor Dr.-Ing. Piwowarsky, of the Technical High School, Aix-la-Chapelle, Germany; (5) "The Importance of Air Control in Efficient Cupola Practice," by Mr. P. H. Wilson, M.I. Mech. E., Foundry General Manager, Stanton Ironworks Company, Ltd.; (6) "The Manufacture of a Large Steel Casting," by Mr. F. A. Melmoth and Mr. T. Brown, of Thos. Firth and Sons, Ltd.; (7) "Strains in Non-ferrous Casting," by Dr. C. H. Desch, F.R.S., Professor of Metallurgy in the University of Sheffield; (8) "The Strength of Cast Iron," by Mr. J. E. Fletcher, M.I. Mech. E., Consultant, British Cast Iron Research Association; (9) "The Effect of Manganese and Manganese Sulphide in Whiteheart Malleable," by Mr. E. R. Taylor; and (10) "High Test Cast Iron," by Mr. F. M. Robbins, Chattanooga, Tennessee.

80 H.P. TURBINE PUMP MOTOR FIRE ENGINE

MERRYWEATHER AND SONS, LTD., GREENWICH, ENGINEERS

80 H.P. Turbine Pump Motor Fire Engine.

A NEW type of turbine pump motor fire engine has recently been constructed by Merryweather and Sons, Ltd., of Greenwich. It is illustrated in the accompanying engraving. Before going on to describe it, we may say that it is just twenty-one years ago since Messrs. Merryweather designed and constructed the first self-propelling fire engine fitted with a pump of the turbine type. It was built in 1906 for a city in South America, and it gave good service, so we understand, for more than fifteen years. A great many improvements have been introduced since that date, and the engine, which we are about to describe, is claimed by its makers to be unsurpassed in all-round efficiency and perfection of mechanism.

The chassis has side frames of pressed steel, which are carried on semi-elliptical springs. The front axle is of forged steel, and is formed with flaps for securing the springs. The rear axle is of the live axle type, and comprises a central drop-forged casing, which contains a bevel type differential gear driven by a worm and worm wheel. The worm and worm wheel castings are mounted in ball bearings, and the axle driving shafts, which float in an oil-bath casing, are connected to the rear wheels by a cap fitted with splines on the shaft and bolted to a flange on the rear wheel hub. The wheels are of the detachable disc type, those in front having single discs, while the rear wheels have double discs bolted to flanges on the cast steel wheel hubs.

The motor is a six-cylinder engine, having cast monobloc cylinders of 100 mm. bore by 140 mm. stroke. It is designed to develop 80 B.H.P. The cylinder castings were tested to 500 lb. per square inch in the bore and 50 lb. per square inch in the jacket, and have large water spaces, especially round the exhaust valve pockets. The detached cylinder head was specially designed by Mr. H. R. Ricardo for the engine. The formation of the Ricardo cylinder head is both novel and of simple construction, the combustion space being offset to a considerable extent in relation to the cylinder bore. The resulting arrangement is claimed to have several advantages, since it ensures effective turbulence with an entire absence of pockets, and a central position for the sparking plug. Other noticeable features are the large size of the valves, and the absence of sharp bends in the induction and exhaust passages.

The exhaust valves are of stainless steel, and the inlet valves are of 3 per cent. nickel steel. The valve springs are held in position by split pins, and the lubrication of the valve stems is effected by the provision of openings between the valve stem chamber and the crank case, so as to permit the oil mist in the crank case to penetrate to the stems. The tappets are adjustable and silent in operation.

The crank case, which is of aluminium, is divided longitudinally, the bearings being in the top half only. The bottom half forms an oil reservoir to hold 3 gallons. The crank shaft is a high-tensile steel forging, drilled for forced lubrication, and a flange is provided to carry the fly-wheel.

The lubrication of the engine is carried out on a complete forced feed system, a large oil pump, which is arranged in the sump, being driven by spiral gearing from the cam shaft. A large strainer is fitted on the suction side to exclude impurities, which are collected in a well provided with a plug for removal for washing out purposes. The delivery side has a detachable oil filter as an additional safeguard against dirt reaching any bearing. An indicator is provided to show the level of the oil in the sump, and a constant pressure is maintained to ensure a sufficient supply to each bearing, the surplus passing by a relief valve to the timing wheels and magneto driving chains.

There are two independent ignitions, and they operate on separate sets of plugs. Both are coupled to one operating lever, and are controlled by a three-way switch on the dash. Two carburetters are fitted, and they are controlled by a foot accelerator, and also by a hand lever on the face of the steering wheel. Access to either side of the engine is afforded by the bonnet of planished steel, which has brass louvres, hinges and fittings.

The change speed gear is designed to give four speeds forward and one reverse, and direct drive on top speed. The brakes are in duplicate, and have been specially designed for fire brigade purposes to enable the vehicle to be pulled up easily when running at high speed. The foot brake and hand lever operate expanding brakes in the rear wheel drums.

The fire pump, which is carried at the rear, is a Merryweather turbine of new design. It has two stages, and is made throughout of gun-metal, the impeller spindle being of bronze. The design is such that no bearing or stuffing-boxes are required at the suction side, so as to eliminate all possibility of an air leak in the pump. The impeller bosses of the pump run in white metal bearings, and the first-stage impeller has an inlet of specially large area to provide for relatively large quantities of water when pumping on deep lifts. The pump is driven through the medium of a silent chain, operated by a toothed wheel in the change-speed gear casing, the driving chain being entirely cased in and running in an oil bath.

The pump is designed to deliver 600 gallons per minute at a pressure of 100 lb. per square inch, 500 gallons at 120 lb., and 400 gallons at 140 lb. pressure. It will also, so we understand, deliver as great a quantity as 800 gallons a minute at a pressure of 50 lb., and will operate economically at a delivery pressure of 200 lb. per square inch when required for use with long lines of hose.

The vacuum pump for charging the suction pipe and main pump is embodied in the same unit as the main pump, and is driven through a hand-operated friction clutch and a toothed wheel speed-reducing gear, running totally enclosed. The vacuum pump plungers are operated by a crank pin fitted between the plungers, which are of large capacity, to enable the suction hose to be exhausted with certainty and rapidity. An intercepting float valve is fitted between the main pump casting and the vacuum pump to prevent the ingress of any large amount of water to the latter, a strainer being provided, in addition, so that water entering the vacuum pump will not carry anything to interfere with the vacuum pump valves. There are four delivery outlets, two on each side, and each is controlled by a separate shut-off valve.

The bodywork, which is all of mahogany, includes a main box with seating accommodation for the driver, officer and firemen, and to carry 1000ft. of canvas hose and other gear. At each side of the box there is a footboard with troughs to carry suction hose. Along each side of the chassis is a box for stand pipes, &c., and to provide standing room for firemen.

American Engineering News.

Proportioning Concrete by Weight.

On all concrete highways built under the direction of the State Highway Commission of Iowa, the specifications require the proportioning of cement and fine and coarse aggregate to be done by weight instead of the usual volumetric measurement. This arrangement has been found to give very satisfactory results, and it is regarded favourably by the contractors, since it can be managed easily and simply, without loss of time and without increased cost of the finished road. The principal advantages are :—(1) A definite relation is maintained between the quantities of materials used in a series of batches of concrete ; (2) errors and variations in proportioning due to the bulking effect of moisture, especially in volume measurement of sand, are reduced, and may be eliminated ; (3) inspectors have a definite control of the proportioning and mixing ; (4) both the engineer and the contractor have reliable records of the quantities used of each material. Moisture determinations are made frequently, and batch weights adjusted correspondingly. Different forms of weighing apparatus are employed :—(*a*) A bottom discharge hopper carried on a lever weighing system with direct-reading dial scale ; (*b*) a batch device with scale weighing system ; (*c*) a bottom-discharge hopper on platform scales ; (*d*) a side-discharge hopper on platform scales ; and (*e*) a bottom-discharge hopper on pipe lever weighing system. Cement weighs 94 lb. per sack, and occasional check weighing shows that this amount is very uniform.

High-speed Oil Engines.

Manufacturers of oil engines of the hot-bulb type are developing high-speed designs with a view to competing with the gasoline or petrol engines used so extensively in automobiles and for such construction machinery as power excavators, logging cranes, rail-laying cranes and oil well drills. The difference in fuel cost is only a part of the saving. Thus a drag-line excavator with 1¼-yard bucket will operate ten hours on 40 gallons of petrol, or sixteen hours on the same quantity of crude oil. This, in turn, reduces expenses for transportation, storage and other operating items. Oil engines have been operated successfully at about 1700 revolutions per minute, and engines on the market for commercial use have speeds up to 1000 revolutions. Engineers designing machines of this class have not yet given much attention to the oil engine, as petrol is available at a reasonable price, so that the new designs have devolved upon the oil engine builders. For one thing, careful study of design is necessary to ensure that the high-speed engine will have the same life as the slow-speed engines. Reduction in weight is essential, which may be effected by the use of steel or aluminium alloys for castings, in place of cast iron. But this cannot be carried too far without shortening the effective life. In one design of four-stroke cycle engine with airless fuel injection and an ordinary speed range up to 900 revolutions, the weight is 40 lb. per horse-power with cast iron construction ; but that weight is reduced to 30 lb. with aluminium and cast steel parts without greatly affecting the cost of production.

Burning Wood Waste.

In industrial plant development, surprising results have been obtained by more efficient burning of wood waste, from sawdust with 15 per cent. moisture to kiln-dried wood, besides planer chips and long wood shavings from lathes. The handling of blocks and edgings is not difficult, as that material is reduced to dry pulp by a hammer, replacing the old knife "hog" cutter. This hammer "hog" also prepares for the furnace such waste as straw, paper, cardboard boxes and straw. According to a paper read at the American Mid-West Power Conference by Samuel G. Neiler, the economical burning of wood refuse has been promoted mainly by attention to furnace design. The old and still used method of delivering the fuel through pipes leading directly from collector heads to the furnace is not considered good practice owing to excess of air entering with the fuel, lack of uniform feed, absence of feed control, and uneconomical burning without assurance of smokeless combustion. Furnaces for such fuel are preferably of the Dutch oven or combustion chamber type. With such a furnace for horizontal water-tube boilers, an evaporation of 4·33 lb. of water per pound of fuel has been obtained from sawdust of kiln-dried wood containing 7·57 per cent. of moisture. The fuel may be fed from a bin by a screw conveyor discharging through openings in the roof of the "oven," and this has been applied to four vertical tubular boilers, each of 5100 square feet of heating surface. A plant for burning wood and coal together delivers the wood through the roof and the coal to a horizontal underfeed stoker beneath the grate of the "oven."

THE INSTITUTION OF MINING ENGINEERS.

As previously announced, the eighty-sixth general meeting of the Institution of Mining Engineers will be held at Newcastle-upon-Tyne on Wednesday, Thursday and Friday, June 29th and 30th, and July 1st next. The Council of the North of England Institute of Mining and Mechanical Engineers has placed the House of the Institute at the disposal of the Institution as headquarters during the meeting.

The following programme has been arranged :—On the Wednesday at 10.30 a.m. there will be a general meeting in the Lecture Theatre of the North of England Institute of Mining and Mechanical Engineers, Neville Hall, Newcastle-upon-Tyne, at which the Lord Mayor of Newcastle-upon-Tyne and the President of the North of England Institute, Mr. A. M. Hedley, will welcome the Institution on behalf of the City of Newcastle-upon-Tyne and the Institute respectively.

The chair will be taken by the President, Dr. J. S. Haldane, F.R.S., and papers—a list of which will be issued later—will be submitted for discussion. In the afternoon there will be alternative excursions to :—(*a*) Consett to inspect the coke-oven and by-product plant and the works for the manufacture of silica bricks of the Consett Iron Company, Limited ; (*b*) Messrs. John Bowes and Partners' Wardley Colliery, and the coal-cleaning plant by the Birtley Iron Company's dry-cleaning systems ; the party subsequently visiting the works of Clarke, Chapman and Co., Ltd., Gateshead to inspect their dust-firing plant ; (*c*) the Kœpe Winder at the South Hetton Coal Company's Murton Colliery ; (*d*) the modern headgear and surface equipment at Watergate Colliery belonging to the Priestman Collieries, Ltd. ; and (*e*) the Carville Power Station of the Newcastle-upon-Tyne Electric Supply Company, Ltd., and inspect the modern power plant. At 7 for 7.30 p.m. the dinner of the Institution will be held at the Grand Assembly Rooms, Barras Bridge.

On the Thursday, June 30th, the general meeting in the Lecture Theatre of the North of England Institute of Mining and Mechanical Engineers will be resumed. At 9.45, and in the afternoon there will be alternative excursions to :—(*a*) The Spiral dry-cleaning plant and the large dust-firing plant at the Ashington Coal Company's Ash-

ington Colliery; (*b*) the Team By-product Company's Works to inspect its coke-ovens and by-product plant; (*c*) the Lemington Glass Works; (*d*) the new sinkings in water-bearing Permian measures by the freezing process of the Londonderry Collieries, Ltd.; (*e*) the works of J. H. Holmes and Co., Ltd.; and (*f*) the Durham and Northumberland Collieries Rescue Station. At 8.30 p.m. there will be a reception by the Lord Mayor and Corporation of Newcastle-upon-Tyne at the Laing Art Gallery, New Bridge-street. On Friday, July 1st, there will be an all-day excursion to the Roman Wall.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Whitsun Holidays.

OWING to the Whitsun holidays and the consequent reduction of iron and steel consumption, trading conditions in the Midlands and Staffordshire have been extremely quiet this week. Most of the industrial concerns in this district are none too well off for orders, and with few exceptions works were idle till Wednesday or Thursday. Engineers and manufacturers do not speak any too highly of the immediate trade prospects. While constructional engineers are steadily engaged in practically all branches, no substantial contracts are being given out. Heavy iron-founders are experiencing difficulty in finding sufficient new business to replace completed contracts. Heavy edge-tool works in this area are encountering slightly improved demand from overseas. Little change in conditions, as existing a week ago, is to be noticed in the various sections of the iron and steel trades. Consumers are still inclined to postpone buying, and the tonnages changing hands are of the smallest possible character. Further reductions in iron and steel prices have not brought with them any revival in buying, and some Midland producers are inclined to take a gloomy view as to the prospects for the near future. In all branches consumers are refraining from placing contracts for forward delivery in the belief that prices will go still lower.

Bar Iron Prices.

The Staffordshire finished iron trade continues poorly employed, but some increase in business is expected now that the trade has, by reducing prices of marked bars by 20s. per ton, brought itself into unison with the new prices of pig iron. Moreover, the fall in price will, it is hoped, give a much-needed impetus to Black Country industries. Since December last Staffordshire marked bars had stood at £14 10s., and the new figure of £13 10s. is lower than it has been for some years. Except for a period following the collapse of 1922, marked bars have not been procurable at such a price since the war. What the effect of this may be on other categories of finished iron can only be conjectured. There was not enough business being done on 'Change in Birmingham to-day to afford a test. So far, no new life has been infused into demand. The orders reaching the rolling mills are small and infrequent, and there is little to induce ironmasters to make price adjustments, which would, so far as can be seen, do nothing to broaden consumption. Ordinary Cleveland bar iron has been reduced from £11 15s. to £11 5s. Scottish makers by a like reduction have brought their basis for Crown bars down to £10 15s. This price has been quoted on the Birmingham market for a Midland make of Crown bars, but it is below the rate hitherto recognised by Staffordshire and Lancashire houses, which mainly serve the local trade. Nut and bolt and fencing iron continues to be quoted £10 5s., but Black Country manufacturers are scarcely interested. Belgian No. 3 iron is so very much cheaper that practically all local users' supplies are drawn from that quarter. Wrought iron gas tube strip is in fair demand at £12 10s., but works here are not so busy as they were, and calls upon the manufacturers are becoming less regular.

Raw Iron.

Demand for pig iron, alike foundry and forge, is poor. It was hardly expected that the recent abstention from buying practised by consumers would have been maintained in face of the substantial reductions in pig iron values, but such has proved the case. Consumers of pig iron are apparently convinced that prices will fall still further, and are therefore holding back orders. It is estimated that quite half of the iron produced is going into stock, owing to the poor demand. The furnaces relit in this district after the stoppage are only few in number, and so far operations have been maintained, but curtailment of output is increasingly talked of unless improvement comes and that quickly. Prices are easy at £3 12s. 6d. for Derbyshire No. 3 foundry and £3 7s. 6d. for Northamptonshire. Some makers are unwilling to sell Northampton below £3 10s., but business has actually been done at £3 7s. 6d., and if consumers are to be persuaded to enter into contracts at all, the lower figure would probably be the basis. Indeed, it is this week reported that several Northamptonshire furnaces have placed some thousands of tons of their output by making still further price concessions. Offers of £3 10s. have been made for Derbyshire foundry iron. They were not definitely rejected. Representatives on 'Change in Birmingham to-day were not prepared to negotiate business at that figure, but offered to submit it to their principals. The menace of foreign competition in pig iron, though still active at Middlesbrough, is not serious in the Midlands. After freight rates had been added, Belgian pig would not be competitive, so that continental purchases are mainly concerned with semi-finished and finished products.

Quiet Steel Demand.

Conditions in the steel department are quiet, but firm. Demand is fairly regular for most classes of structural material, but semis are not in large request. Values show no sign of descending further. There is no longer any stringency with regard to the ordinary descriptions of steel. Some mills which started the year with rosy prospects are now poorly off for orders. The continued call for constructional material continues a hopeful feature in the steel trade. Local engineers are receiving regular inquiries, although the aggregate tonnage involved is not large. Material is comparatively easy to obtain from the makers, most mills being able to give delivery of joists and sections in about three weeks. Angles and joists continue to be quoted £7 12s. 6d.; ship, bridge and tank plates, £8 7s. 6d.; boiler plates, £11 to £11 10s. Staffordshire hoops stand at £10 10s. at works. Small steel bars make £8 upwards; billets, £6 15s. to £7. Continental competition remains keen. Some Birmingham merchants are still handling fair quantities of strip, both hot and cold rolled, which can be bought on advantageous terms from Belgium and Germany. Both iron and steel bars from Belgium cost about £5 16s. 6d. Billets can be had at £5 10s. and sheet bars £5 12s. 6d. Continental prices are firm.

Galvanised Sheets.

Galvanised sheet mills in this district have a steady flow of small orders, but inquiries for large tonnages are somewhat scarce. Sheets of 24 gauge are maintaned at from £14 12s. 6d. to £15. Thinner gauge sheets are in fair demand, and values are steady.

West Midlands Electricity.

The opening at Stourport of the new electrical generating station of the Shropshire, Worcestershire and Staffordshire Electric Power Company, and the Prime Minister's reference to a scheme for central England, have directed attention to the work in hand by the West Midlands Joint Electricity Authority. It is proposed, subject to the necessary sanction, to acquire land at Ironbridge on which the Authority proposes to erect a new base-load station, similar in many respects to that at Stourport. The cost of the first section is estimated at £1,250,000. In the meantime, to meet increased demands in the eastern portion of the district, important extensions are being carried out at Birchills generating station, Walsall, and Ocker Hill generating station, Tipton, at an estimated aggregate cost of nearly £400,000, and four large electrical sub-stations at Wolverhampton, West Bromwich, Walsall and Tipton are being provided, in which the switchgear alone will cost about £125,000. The work of laying the 33,000-volt interlinking trunk mains is being proceeded with as fast as possible, and already several miles have been laid. The question of the extension of electricity into urban and rural areas in Shropshire is being dealt with, and it is expected that distribution schemes for the principal districts will be evolved as soon as the demand for supply is known.

Road Transport and Canal Bridges.

A question of vital importance to the trade of the Birmingham and Black Country district has arisen in connection with heavy motor transport over canal bridges. The Birmingham Canal Navigations has posted notices on a very large number of bridges over its canals specifying the maximum limits of the weights which may pass over the bridges, and has also written letters to various firms, the business of which requires the transport of heavy loads. So important is the matter that the Birmingham Chamber of Commerce has issued a memorandum on the subject in which it points out that these bridges were built perhaps more than a century ago, and that a canal company or railway company is only liable to maintain a bridge in the same condition as to strength in relation to traffic as it was on the date of completion, and is not liable to improve the strength or reconstruct it to make it sufficient to bear the increased traffic of the district. We are therefore brought face to face with a problem which appears to be absurd, a problem which has first the widening, improving and strengthening of roads, and, on the other hand, bridges of an archaic character, and no one charged with the obligation of bringing them up to the level of the efficiency of the approaches on either side. It is almost inconceivable that such a condition of things could exist at the present time. Throughout Great Britain there are many thousands of these archaic bridges, but perhaps there is no district in which the conditions appear to be so hopeless as they are in the neighbourhood of Birmingham and the Black Country. There are firms which cannot even get out of the vicinity of their works without crossing a canal bridge. There are cases in which even the railway companies' collecting vehicles cannot collect and carry to their railway stations without passing over one of the bridges referred to. Road transport in heavy traffic cannot be effectively carried out unless steps are taken to ensure that the vital links in the shape of bridges over canals are brought more or less up to date. A deputation consisting of representatives of the Dudley, Walsall, Wolverhampton and Birmingham Chambers of Commerce has placed the matter before the Chief Engineer of the Ministry of Transport, but it appears to have been of no avail, it being pointed out that the Ministry has no control over the management of highways, but is only in the position of a subsidising authority. It would, from the economic point of view, be disastrous if canal and other bridges throughout the country should be allowed to interrupt through traffic in any way whatever, and it is therefore most essential that steps should be taken to ensure as far as possible the difficulty referred to being overcome. It is recommended that the matter be taken up with the Midland Association of Local Authorities. At the present time the companies and authorities responsible for the maintenance of bridges are required to maintain them in a reasonable manner, and it is thrown out as a suggestion that the responsibilities of canal companies should be taken over by them, either on the payment by the company of a capitalised lump sum or of a payment of an annuity for a sufficient number of years for release from their existing statutory responsibility.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

A Notable Centenary.

LANCASHIRE in general and Bolton in particular have been celebrating this week the centenary of the death of Samuel Crompton, who, as the inventor of the original spinning mule, did more than any other individual, to lay the foundation stone of Lancashire's present-day greatness as a cotton manufacturing area, and—of more direct interest to engineers—of her pre-eminence in the making of textile machinery. It is in the town of Bolton, the birth-place of Crompton and the scene of his early labours, which led up to the invention of the mule, that the celebrations are taking place. One of the principal features is the exhibition of early and modern textile machinery and accessories, arranged by the Bolton Technical College. In the former category many of the mechanical products of Crompton's ingenuity naturally take pride of place, although between these exhibits and the latest appliances turned out by the modern textile machinist are numerous interesting relics, from which one can trace the lines along which developments have progressed. The Technical College exhibition of textile plant has been divided into permanent and temporary sections, the latter, of course, being organised primarily in view of the present week's celebrations. In the permanent section, however, a number of the most modern types of machinery have been added to the mechanical equipment of the College, and it is claimed that it is better fitted than any other institution in the world for imparting to students knowledge of the technology of cotton textile manufacture.

Engineering Trade Conditions.

The official review of the Manchester Chamber of Commerce of conditions in the engineering industry during the past month discloses both bright and cloudy patches, with, however, the latter predominating. It is pointed out that many engineering firms had a dull time during May. Contracts were keenly competed for, and the terms arranged were often unsatisfactory in themselves, their acceptability being chiefly due to the fact that the work would help to keep things going. Some electrical engineers were well employed, and so also were cable makers and constructional engineers, generally at remunerative prices. The partial revival of shipbuilding benefited others, marine engineers especially having many orders on their books. The experience of textile machinists was varied. The chairman of one large Lancashire company recently told the shareholders that their works were very busy, and that their machines were in ever-increasing demand. Some others, however, are not doing anything like so well as this. Locomotive builders are only moderately busy, and boiler makers are still insufficiently employed. The machine tool trade also continues very quiet.

Non-ferrous Metals.

Fluctuations in the prices of non-ferrous metals have again been in evidence during the past week, but in striking contrast to the experience of the last month or so all sections of the market are stronger on balance. Tin has about fully recovered the loss sustained a week ago in spite of the bearish influence of the monthly statistics, which showed a substantial gain of about 10 per cent. in total visible supplies. This recovery, however, had been fully expected during the previous week or two, and the effect on market values had already been more or less discounted. An improvement in the demand from United States users has been a factor which has helped to stiffen values, the net gain in cash metal compared with a week ago being in the neighbourhood of £4 10s. per ton. The tone of the market is felt to be better than it has been of late, although so far there is little indication of freer buying on the part of domestic consumers. In the copper section a better inquiry from home users, coupled with an improvement in the United States demand, has helped matters along, and a further slight appreciation in values has resulted. Supplies of lead continue to exceed the demand for the metal, but in spite of this prices, after their steady fall during the past three or four weeks, have made a substantial recovery, quotations at the time of writing being about £1 a ton better than they were a week ago. A slight expansion of European buying has, no doubt, had a beneficial effect, but a further factor has probably been the expectation of a concerted policy of output reduction among United States producers. There has been no perceptible improvement in the demand for spelter, but, largely in sympathy with the other non-ferrous metals, prices are better than they were at the time of my last report, and the position is believed to be stronger.

Iron.

Apart from the fact that some varieties of pig iron are slightly cheaper again, there is little fresh that can be reported of the iron and steel markets here, principally because business is practically at a standstill on account of the Whitsuntide holidays, the majority of firms in the Manchester district being closed down for the greater part of the week. As a result, little buying interest is being taken in any section. For delivery Manchester or equal, Midland brands—both Derbyshire and Staffordshire makes—are now obtainable at about 80s. per ton, a figure which would very likely be reduced a little if sufficient inducement in the shape of business were to present itself. Scottish makes are easy at 98s. per ton delivered into this area, as are also hematites, both East and West Coast being obtainable at about 92s. 6d. Up to the present, however, there has been no further modification of values in the case of Middlesbrough foundry iron, and quotations for this material, delivered into Lancashire, remain at 83s. 2d. per ton. Lancashire bar iron presents no new features, and the demand for it is also suffering from holiday influences. Crown bars are offered at £11 and seconds at £10 per ton.

Steel.

Actual orders for steel placed during the past week have been extremely light in weight and sellers have secured no business of any consequence. Even after the holidays, however, it will be a matter for surprise if there is any bigger volume of buying than has been experienced during the past month or so, for users still seem determined to wait for substantially lower levels before, at all events, entering into forward contracts. Boiler plates are quoted at £11 5s., ship plates at £8 7s. 6d., sections at £7 12s. 6d., and steel bars at from £8 2s. 6d. to £8 15s. per ton. Continental steel is attracting little or no attention at the moment and prices are largely nominal.

BARROW-IN-FURNESS.

Hematite.

The position in the West Coast hematite district has suddenly undergone a change. The reduction in price has not been sufficiently tempting for the customers, and as the extensive orders placed during the dispute have since been nearly completed, the makers have decided to reduce production. A furnace is out at Barrow; another is out in Cumberland, and other works are watching the position carefully, none of the makers being inclined to create stocks at the present time. Customers, it is known, will be requiring iron, but they are holding off until the last moment, considering present prices too high. The factor in the whole position appears to be the price of coke. Unless this goes down substantially, the pig iron trade is going to suffer. At Barrow the steel departments are taking a considerable proportion of the present outputs of iron, but the future of the steel trade is not so secure as to create optimism locally. By the damping down of furnaces the local ore trade is naturally affected, and deliveries, not only from the local mines, but those in Spain, Algiers and Norway, may also be affected. Holidays have rendered certain departments idle in the steel trade, and no railway material will be turned out for the next week or so at Workington. The hoop and small section mills at Barrow are well situated, and hold orders which will keep them fully engaged.

The Prince's Visit.

The Prince of Wales pays a flying visit to Barrow on June 29th. He will go to the Barrow Hematite Steel Company's works, and see some of the processes, after which he will motor through the town to Vickers Ltd.

SHEFFIELD.

(From our own Correspondent.)

The General Steel Trade.

THE position at the open-hearth steel works of the district does not improve, and, now that arrears of work are almost all executed, the scarcity of new business is causing some anxiety. Not many of the plants have a week's work on their books. The managements are making determined efforts to keep running and to avoid the closing of furnaces and the suspension of large numbers of workers. To this end, material is being put into stock and used up in various ways. Obviously, however, this course cannot be pursued indefinitely. Prices of material are again easier. Blast-furnace coke, which two months ago stood officially at 22s. per ton at the ovens, has now fallen to about 14s. 6d., which is only 9d. more than the price obtaining before the coal dispute. For Derbyshire and Lincolnshire pig iron, it is said that lower prices have been accepted than the current quotation of 72s. 6d. per ton. Basic steel prices have also been reduced. As yet, however, these movements have not stimulated demand. Steel users have not been placing orders for English billets for a considerable time, and they still hold off the market, although they are without stocks.

Continental Competition.

Some concrete facts with regard to the present position were given by Mr. Douglas Vickers, the chairman of the Parkgate Iron and Steel Company, Ltd., at the annual meeting of shareholders a few days ago. He said that since the works were restarted, after the resumption of work at the collieries, they had operated at practically their full output. In spite of this fact, the revival in the steel and heavy trades which they had been led to expect in the earlier part of the year had never been realised. There was a great demand for steel from people who placed orders before the stoppage, but the new orders had not kept pace with the deliveries. Last month they worked off from their order book 6000 to 8000 tons more than the orders they took in. This situation was very largely a consequence of the great importation of steel from the Continent. During the first quarter of the year the returns showed that the steel imports amounted to 1,882,000 tons, whilst the steel manufactured in this country was 3,357,000 tons. In both cases the figures were a record, but whether the steel produced in this country was likely to remain a record it was difficult to say. There seemed to be far more steel made and coming in than could be consumed, and that fact accounted for the difficulty in getting orders.

Various Branches.

The rolling mills which serve the finished steel trades report that they are unable to keep up regular running, owing to the tapering off of work. There is a good deal of activity in steel forgings and castings for electrical and general engineering of a special character, these being among the briskest branches of local trade. The demand for high-speed steel is only moderate. In engineers' and agricultural tools, as well as in machine knives, fairly good business is being done, but it is complained that price cutting makes most of the transactions unprofitable. There is an increasing output of various forms of corrosion-resisting steels. It has been found that such alloys, besides being immune from rusting and staining, possess valuable properties of resisting the destructive influence of high temperatures. Special forms of chromium steels are now being made primarily for use where at extremely high temperatures metallic parts have to remain rigid or even to support loads.

Some Contracts.

Sheffield is interested in the fact that the Vulcan Foundry, Ltd., a firm with which Hadfields, Ltd., are associated, has obtained a further contract from the London, Midland and Scottish Railway Company for fifty locomotives. The firm is now completing delivery of the fifty three-cylinder compound locomotives for the railway which were ordered some time ago. Hadfields have been successful in obtaining, in the face of American competition, a contract for the supply of junctions and crossovers for the Newcastle Corporation tramways. The Sheffield firm's tenders were higher than those of a United States firm, being £1490, against £1360 for the junctions, and £960 against £955 for the crossovers. The Tramway Committee recommended the acceptance of the lowest tenders, but an amendment in favour of giving the work to the British firm was carried by 36 votes to 8. A case in which work has been sent out of this country because of a large difference in price comes from Doncaster. On the recommendation of the Electricity Committee, the Corporation has accepted the tender of a Dutch firm for low-pressure cables, at a price of £2620, which the chairman said was £822 less than the lowest offer from a British firm. He added that the same specification was sent to both British and Dutch firms. There was no member of the Committee less keen than himself on going outside England to make such a purchase, but they wished to show British contractors that if they wanted to do business with the Doncaster Council they would have to come down to their price.

Cutlery and Plate.

The British public is at present buying very little cutlery or plate, and firms in these trades who depend upon business with the retail shopkeepers are doing badly. Not much better conditions are reported in other cases, although a fair amount of trade is being done with the Dominions and Colonies, and generally speaking, these branches are suffering from depression. There has been a substantial drop in the sales of stainless knives, and firms supplying handles state that their sales fall a long way short of those of last year. Spoons and forks plated with pure chromium on nickel silver are now being offered by several firms. The prices approximate to those of medium quality electroplate, and it is claimed that the chromium coating will last a lifetime. Last year a company called Stainless Plating, Ltd., was formed to develop the deposition of chromium, and especially to explore the possibilities of its application to marine, railway, tramcar and motor fittings. Very considerable progress has been made since the company began operations. The largest chromium plating plant in England has now been installed at the Chrome Plate Works, Sheffield, where a big output is already being attained, and more plant is being erected.

Big Firm to be Reconstructed.

Something of a sensation was caused in Sheffield last week by the announcement that William Deacon's Bank, Ltd., had presented a petition for winding up of the firm of Darwins, Ltd., which petition is to be heard in London on the 14th inst. Darwins, Ltd., is a remarkable firm, to which I have referred on previous occasions in connection with its mass production of safety razor blades and its attempts to capture the world's markets in these goods. Under the management of Mr. P. R. Kuehnrich, who has been in the Sheffield steel trade over thirty years, it has incorporated upwards of a dozen other concerns, and makes not only razor blades, but also high-speed steel, tool steel, hacksaw blades, magnets, wire for drills, tools and ball races. It has come most prominently before the public in connection with safety razor blades, of which something like a million a week are now turned out at the very fine Fitzwilliam Works, Tinsley, Sheffield, where some 2000 girls are employed on the various processes. Mr. Kuehnrich has informed the local Press that the company is to be reconstructed. "We have plenty of work and plenty of orders," he says, "but we want more capital."

From Sheffield to Birmingham.

It is announced that Padley and Price, Ltd., specialists in manufactures from stainless steel, of Hill-street, Sheffield, are about to transfer their business to Birmingham, where they have taken over a works covering two acres. The change is not due to any dissatisfaction with Sheffield, but to the fact that the firm was unable to obtain in the city either a site or unoccupied premises which suited its requirements for extended productive capacity and future expansion. The firm is a pioneer in applying stainless steel to the manufacture of scores of different articles. Its removal does not affect the associated business of Padley and Venables, steel and tool manufacturers, which will still be carried on as usual at Hill-street, Sheffield.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Outlook.

THERE is still a considerable lack of confidence in the trade outlook in the North of England. The situation in the coal industry has become very serious, owing to the diminishing demand from the Continent. Several collieries have already closed down, and fear is entertained that, unless substantial expansion of demand is experienced in the near future, more will have to be laid idle. The general position in the iron and steel trades continues unsatisfactory and discouraging. The total volume of business passing is still on a very disappointing scale, and is by no means sufficient to keep firms actively employed as work in hand is completed. A firmer feeling in continental commercial circles is welcome, promising, as it does, to lessen to some extent the keenness of foreign competition, but prices of most material manufactured abroad are still considerably below quotations for the products of this district. The substantial curtailment of pig iron production in this area by the damping down of three hematite furnaces and two furnaces on Cleveland pig iron leaves output still too large for the limited demand, with the result that stocks continue steadily to increase. The number of blast-furnaces in operation on the North-East Coast is now forty-two, of which twenty-one are manufacturing Cleveland pig iron, nine hematite, and twelve other kinds of iron.

Cleveland Iron Trade.

The amount of business done in the Cleveland pig iron trade this week has been very small. There have, however, been indications of a slightly better tone. French foundry iron has been sold in considerable quantities on the United States Atlantic seaboard, and this possibly accounts in some measure for the fact that continental sellers are less inclined to press for business here. Apparently, there is some hope of a more extended market for Cleveland iron as soon as deliveries from the Continent under running contracts approach completion. There is still a disposition on the part of many consumers to hold off the market in the hope of further price concessions, but ironmasters affirm that current quotations are altogether unremunerative, and if they fail to sell at ruling rates they will cease manufacture. No. 1 Cleveland foundry iron is 72s. 6d.; No. 3 G.M.B., 70s.; No. 4 foundry, 69s.; and No. 4 forge, 68s. 6d.

Hematite Pig Iron.

East Coast hematite output has been reduced to an extent that should enable makers to get rid of some of the iron accumulated at their yards. Producers are keenly pressing sales, however, and do not hesitate to accept below recognised market quotations when a good order is offered. For mixed numbers 79s. is asked, and No. 1 grade is put at 79s. 6d.

Ironmaking Materials.

Business in the foreign ore trade is practically at a standstill. Consumers have large stocks, and heavy deliveries are coming forward under running contracts. Best Rubio ore is nominally 22s. per ton c.i.f. Tees. Blast-furnace coke is a little easier at 21s. 6d. per ton delivered at the works, but ironmasters are hoping for better terms.

Manufactured Iron and Steel.

Nearly all the steel works in this area closed down for two days during Whitsuntide, operations being resumed on Wednesday. Manufacturers have fairly good order books, but new business matures very slowly. A few home orders for certain descriptions of steel have been secured, and foreign buyers are reported to be taking rather more interest in this market, but purchasers, both at home and abroad, continue to act with caution, and transactions are mostly for small parcels. Prices are well maintained.

Iron and Steel Imports.

The intensity of the foreign competition in the iron and steel trade is reflected in the return of imports into the river Tees presented at Wednesday's meeting, of the Tees Conservancy Commission. During the past seven months 248,589 tons of iron and steel were imported—more than double the quantity received during the corresponding period of 1925–26, and nearly six times more than in the pre-war period of 1913–14. Crude sheet bars, billets, blooms, slabs, &c., unloaded during the seven months totalled 132,123 tons, as compared with 76,912 tons in 1925–26 and 27,413 tons in 1913–14. The imports of pig iron reached 80,944 tons, as compared with 37,935 tons and 181 tons, and plates, bars, angles, rails, joists, &c., totalled 35,522 tons, as against 8458 tons and 15,124 tons.

The Coal Trade.

The trend in the Northern coal trade is not encouraging to operators, for while the market is generally quoted steady for prompt, the forward position is weak. The main cause of the steadiness in the prompt situation is, of course, the decreased output owing to the holidays, and also the French situation, seeing that many orders for French ports are being brought forward and pressed for spot loading, so as to get the coals into France before the new licensing regulations are fully put into force. The anticipation that there may be some modification of the French import licence decree regarding coking coal is strengthened by the knowledge that in the last few days a large quantity of Durham coking coal has been sold to France. This coal has long been favoured in France for industrial purposes, and may continue to be so, just as lighting and public utility undertakings may go on preferring high-class Durham coal. There is no duty under the import licence scheme, and therefore the competitive conditions are unchanged. Best Northumberland steams range from 14s. 6d. spot to 14s. 3d. forward; seconds, 13s. 9d. to 13s. 6d.; and smalls, 10s. 6d. to 10s. 3d. Best Durham gas coals are held steadily at 16s. 6d. to 17s.; and second qualities, 14s. 3d. to 14s. 9d. There is still a good demand for gas coke at from 19s. 6d. to 19s. 9d., but other grades of coke are weak and offered freely. Good class patent coke is quoted 20s. to 22s., and superior makes 28s. Beehive coke is scarce and nominal at 30s. to 35s.

SCOTLAND.

(From our own Correspondent.)

Seven-mile Cables.

THE second of two cables made to the order of the Glasgow Corporation in connection with the Glasgow District Subway Railway, has just been delivered. The

first was manufactured by J. and E. Wright, Ltd., of Birmingham, and the second by R. S. Newall and Son, Ltd., of Liverpool. These cables, which will replace those at present in use, are each 7 miles in length, 56 tons in weight, and 4¼in. in circumference. They are each made in one continuous length, without joint or splice.

Shipbuilding Orders.

It is reported that the Blythswood Shipbuilding Company, Ltd., Glasgow, has received an order to build two cargo and passenger vessels of 10,000 and 11,000 tons for Liverpool owners. These vessels will have engines of the Kincaid-Harland-B. and W. internal combustion type, and are to be capable of a speed of 11½ knots.

Steel and Iron.

Nothing has occurred during the past week calculated to inspire confidence in the future, and markets generally are dull and uninteresting. Buying in the steel market is, on the whole, merely of a hand-to-mouth description. Only a limited number of works are able to keep their departments fully occupied, and the problem of securing fresh business is not lessened by increasing foreign competition. At the present rate of production, orders on hand will soon be worked off and makers will be on the outlook for fresh business. Meanwhile, the basis of quotations is unchanged. Bar iron makers have not yet reaped any benefit from the latest reduction in prices. For home delivery Crown bars are quoted £10 15s. per ton, while a good export order might be placed somewhat under that figure. Re-rolled steel bars also are inactive, and although prices for the home trade are unchanged at £8 2s. 6d. per ton, export business can be done below that figure; in fact, the export price tends to shrink considerably.

Steel Sheets.

The prices of the lighter gauges of black and galvanised sheets are firm, as a result of the advances in continental billets and sheet bars, even though these advances are somewhat balanced by the cheaper price of spelter. While light sheets are busy, heavy gauges, on the other hand, are in need of fresh orders.

Imports and Exports.

Imports of iron ore at Glasgow during the past week showed a considerable decrease at 5100 tons. In fact, that total was almost the lowest on record. Imports of iron from continental ports totalled 1800 tons. The exports of iron to Australia were fairly large, and along with consignments to New Zealand, Natal, Calcutta, Japan and China, reached a total of 5300 tons. Structural material, tubes, and machinery in considerable bulk were also shipped.

Coal.

The depression in the coal trade has not lessened during the past week, and the outlook is far from bright. Outputs have already been restricted as far as possible, and in all probability many concerns will require to close down entirely until trade revives. Home demands for all purposes is far below normal, while the export turnover has shrunk to very small dimensions. In practically all districts round coals are easing, and the only firm feature throughout is treble nuts. Aggregate shipments amounted to 252,490 tons, against 219,864 tons in the preceding week and 207,534 tons in the same week in the year 1925.

A Coal-selling Agency.

Representatives of the Coalowners' Association have under consideration the formation of a central selling agency, and it is understood that the result of their deliberations will be submitted to a joint meeting within the next few days.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

LOADING activity at South Wales ports was a little more marked last week, as exports of coal amounted to just over 460,000 tons, as compared with close on 450,000 tons the previous week. This was doubtless due to the efforts to get away tonnage before the holidays, and was not brought about by an increased demand for prompt supplies of coals. The shipments effected were in execution of sales made some time ago. As a matter of fact, business has been at a standstill for practically a week, and it can scarcely be denied that most people who have interests in the coal export trade were very glad of the holidays to enable them to get away from the very depressing conditions which prevail. There is no sign anywhere of an immediate improvement, as the inquiries on the market are very meagre. Apart from the fact that the Great Northern Railway of Ireland is inviting tenders for 100,000 tons of steam coal there was no notable inquiry about. The continental demand displays no indication of reviving, Italy being very quiet, Spain and Belgium featureless, and the French market in a state of uncertainty. Any hope of life being infused into the coal market as the result of the continued strike of the union miners in the United States is very slender, as, from all accounts, the stocks of coal have not been appreciably reduced, while the output from the non-union mines can easily be increased should it be really desired. The prospects of American buyers coming to this country for supplies of coal for some months, if at all, are consequently very meagre. In all the circumstances the outlook for the next few weeks, at any rate, is somewhat depressing, and it is feared that quite a number of collieries, which are now working short time, will have a very narrow escape from having to suspend operations altogether for a time.

Coal Shipments to France.

Since writing a week ago the position regarding shipments of coal from this district to France, instead of improving, appears to have become worse. Later information shows that the period within which shipment could be effected without the necessity of obtaining an import license had been extended to the 10th inst., but very disquieting news reached this market on Saturday last, when it became known that local firms which have contracts for the supply of coals to the French State Railways had received telegrams from Paris informing them that licenses had been refused for cargoes due to sail immediately. Later telegrams authorised the completion of the loading of steamers which had already been begun, but other steamers which were chartered were not allowed to load. In one or two cases steamers' charters have already been cancelled, so that the conditions which prevail are making it very difficult, not only for coal exporters and colliery owners, but for shipowners as well. The news from the other side of the Channel is altogether very conflicting, as although in some cases it is stated that there is no difficulty in obtaining licenses to import coals into France, the position in others is the very reverse. It appears that the firms which are to be adversely affected most are those who have contracts for the supply of coals to the French State Railways and other important undertakings of public service. It is estimated that contracts are held by local firms for the supply of about a million and a half tons of Welsh coals for the French State Railways. Whether attempts are to be made to effect the cancellation of these or any part of them under the powers of the Decree is not certain, but it appears to be very clear that the period of the delivery is to be extended materially, as the monthly quantities are to be cut down, so that the coal market is bound to suffer. It is understood that the application of the system of import licenses is extended to Algeria, but doubts are entertained whether this can be maintained, as French collieries cannot compete with this market in the supply of coals; at least that is the opinion of many.

Craftsmen's Wages.

The Executive Council of the South Wales Enginemen's, Boilermen's and Craftsmen's Association met last week to consider the coalowners' proposals for a reduction in the subsistence wage from 8s. 0½d. to 6s. 10d. per day, when it was decided that it could not possibly agree to it, and the matter will be discussed with the coalowners at a joint meeting this week.

Closure of Dock.

There was a conference at Swansea last week between representatives of the Great Western Railway Company, the Swansea Corporation and other private interests regarding the proposal to close the North Dock at Swansea, which is obsolete. The idea is to fill it in, thus placing at the disposal of the railway company a large area which could be used to advantage for development purposes without in the least encroaching upon the shipping facilities of the port, as these have been improved considerably at the other docks. It was arranged as the result of the conference that the officials of the Great Western Railway Company and the Corporation should collaborate with a view to devising a scheme for the closing of the North Dock so far as these parties are concerned, Sir Felix Pole in the meantime to come to an arrangement with Messrs. Weaver and Company, who have a substantial interest in the matter.

Colliery Dispute Settled.

The dispute which last week resulted in the stoppage of work of about 2000 miners at the Marine Collieries, Cwm, Ebbw Vale, as the outcome of the dismissal of three fanmen, was settled on amicable lines on Saturday last, and it was arranged that work should be resumed on Wednesday of this week at the same time as the workmen throughout the coalfield.

Tin-plate Trade Depression.

Owing to the depression prevailing in the tin-plate industry a number of works will not be operating at all this week. In fact, it is estimated that not more than 60 per cent. of the mills will be at work throughout this week.

Current Business.

Business on the coal market has been at a standstill, and in all the circumstances prices are practically nominal. It will be next week at the earliest before anything like settled conditions will prevail, and even then it is doubtful whether much activity will be in evidence, as the inquiry from all directions is so dull. Collieries are likely to have a poor time on the whole, although hopes are entertained that as the result of the arrival of steamers over the vacation sufficient supplies will be in dock to enable a number of undertakings to find an outlet for some of the coals which they have standing. On Saturday last there were no less than fifty idle loading berths at the various docks in this Channel, this being the highest figure since the very early part of this year.

LAUNCHES AND TRIAL TRIPS.

BEACONSTREET, oil tank steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of Beacon Oil Company, of America; to carry 11,000 tons deadweight. Engines, triple-expansion; launch, May 31st.

IRIONA, steamship; built by Workman, Clark and Co., Ltd., to the order of United Fruit Company, of Boston; dimensions, 357ft. by 48ft. by 31ft. 6in.; to carry passengers and fruit; trial trip, May 31st.

LA SALINA, oil tanker; built by Harland and Wolff, Ltd., Belfast, to the order of Andrew Weir and Co., for the Lago Shipping Company, Ltd.; dimensions, 315ft. by 50ft. Engines, twin-screw triple-expansion, developing 1100 H.P., pressure 180 lb. per square inch; launch, May 31st.

MINMI, steel screw self-trimming collier; built by D. and W. Henderson and Co., Ltd., to the order of James and Alexander Brown, Sydney, N.S.W.; dimensions, 250ft. by 37ft. by 17ft. 4in. Engines, triple-expansion, 19½in., 32½in., and 53in. by 42in. stroke, pressure 185 lb. per square inch; constructed by D. and W. Henderson and Co., Ltd.; launch, May 31st.

SUREWATER, steel screw steamer; built by Cowpen Dry Docks and Shipbuilding Company, Ltd., to the order of Water Transports, Ltd., Montreal, Canada; dimensions, 258ft. by 42ft. 6in. by 20ft. 6in.; to carry 2300 tons deadweight. Engines, triple-expansion, 16in., 27in., 44in. by 33in. stroke; constructed by Blair and Co. (1926), Ltd.; a speed of 9¾ knots was attained on trial trip, May 31st.

CASCO, steamship; built by Earle's Shipbuilding and Engineering Company, Ltd., to the order of Canada Starch Company, Ltd., Montreal, Canada; dimensions, 253ft. by 43ft. 3in. by 20ft. Engines, triple-expansion, 17in., 28in., 46in. by 33in. stroke, pressure 180 lb. per square inch; constructed by Earle's Shipbuilding and Engineering Company, Ltd.; launch, May 17th; trial trip, June 1st.

SLIDING CAISSON, for H.M. Dockyard, Devonport; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Admiralty; dimensions, 126ft. by 20ft. 6in. and 55ft. in depth; launch, June 2nd.

Catalogues.

BROOK MOTORS, Ltd., Empress Works, Huddersfield.—Revised price lists for list No. 153.

STAVELEY COAL AND IRON COMPANY, Ltd., Chesterfield.—Monthly stock list of cast iron pipes.

ALFRED HERBERT, Ltd., Coventry.—Twelfth edition of the milling cutter catalogue and price list.

SKODA WORKS, Ltd., Prague, Czechoslovakia.—Catalogue showing the types of locomotives manufactured.

ARNOLD GOODWIN AND SON, Ltd., Sumner-street, London, S.E. 1.—List of pulleys and shafting accessories.

A.F.A. ACCUMULATORS, Ltd., 120, Tottenham Court-road, W. 1.—Price list No. 66 of electric hand lanterns.

E. E. COY, 6, Cambridge-road, Great Crosby, near Liverpool.—Leaflet illustrating the "Atalanta" screwdriver.

LACY-HULBERT AND CO., Ltd., 91, Victoria-street, S.W. 1.—List H 1 showing the firm's latest type of tire inflator.

EMPSON CENTRIFUGALS, Ltd., 47, Victoria-street, S.W. 1.—Leaflet illustrating the Empson centrifugal oil purifier.

THE ATLAS DIESEL COMPANY, Ltd., 35, Surrey-street, W.C. 2.—Brochure of "Atlas" public works contractors' equipment.

STERNS, Ltd., Royal London House, Finsbury-square, E.C. 2.—Booklet describing Kwenchel, a method of quenching steel.

JONES AND LAMSON MACHINE COMPANY, Springfield, Vermont, U.S.A.—Catalogue illustrating "Hartness" flat-turret lathes.

J. H. WILLIAMS AND CO., Buffalo, New York, U.S.A.—Twentieth edition of the general catalogue of drop-forged tools.

SOLEX, Ltd., 223, Marylebone-road, London, N.W. 1.—Booklet dealing with motor car engine troubles and how to overcome them.

INVENTUM ELECTRICAL APPLIANCES, Ltd., 124, Chancery-lane, W.C. 2.—A booklet on the "Inventum" electric water heater.

MELLOWES AND CO., Ltd., Sheffield.—Pocket editions of catalogues on steel casements and sashes, and "Eclipse" patented roof glazing.

PETTERS, Ltd., Yeovil.—Catalogue describing in full the three smaller sizes of oil engines made by the firm, known as the M type.

DRAYTON REGULATOR AND INSTRUMENT COMPANY, Ltd., West Drayton, Middlesex.—Leaflet on the "Drayton" pressure recorder.

BUDENBERG GAUGE COMPANY, Ltd., Broadheath, near Manchester.—Catalogue Section 27, dealing with thermometers of all types.

THE NEW YORK EDISON COMPANY, New York, U.S.A.—A detailed description of the East River generating station of the company.

GRAPHITE PRODUCTS, Ltd., 218, Queen's-road, London, S.W.8.—Booklet F 9, briefly describing the principal "Foliac" graphite products.

ANDREWS AND CAMERON, Kelvin Engineering Works, Kirkintilloch.—Booklet on patented double and triple opening balanced slide valves.

HARDY AND PADMORE, Ltd., Worcester Foundry, Worcester. Leaflet describing a patented gravel washer with sieves, separator and elevator.

FACTORY EQUIPMENT COMPANY, 180, Windsor House, Victoria-street, S.W. 1.—List No. 1 of worm gear, spur gear and triple gear pulley blocks.

THE WESTINGHOUSE MORSE CHAIN COMPANY, Ltd., Letchworth, Herts.—1927 catalogue and handbook of Westinghouse Morse chain drives.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—Catalogue P. 210 on Prescot paper pinions. Also mining cables and accessories catalogue.

THE VACUUM OIL COMPANY, Ltd., Caxton House, Westminster, S.W. 1.—The Gargoyle Technical Series Book No. 26, entitled "Colliery Lubrication."

RANSOME AND MARLES BEARING COMPANY, Newark-on-Trent.—Catalogue giving full particulars of the various types of ball bearings manufactured by the firm.

CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., 170, Piccadilly, W. 1.—The following publications:—S.P. 113, "Pneumatic Paint Scraper and Scaling Hammer;" S.P. 124, "New Type No. 33 Little Giant Grinder;" S.P. 126, "Pneumatic Hammer Coal Pick;" and Electric Tool Catalogue No. 14.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—The summer meetings of the Institution of Heating and Ventilating Engineers are to be held at Bournemouth on June 20th, 21st, and 22nd. On Monday, June 20th, at 5.30 p.m., there will be a council meeting at the Hotel Burlington, and on the Tuesday at 9.45 a.m. members assemble at the Town Hall for a reception by the Mayor, Alderman Thwaites, which will be followed by the reading of a paper by Mr. G. A. Pullen, M.I. Mar. E., on "Notes on the Selection of Pumps for Various Duties." In the afternoon at 3.45 p.m. the Mayor and Mayoress will give an At Home at the Town Hall, and at 7 p.m. there will be a banquet at the Hotel Burlington. On the Wednesday there is to be a circular motor drive, *viâ* the New Forest and Salisbury, to Shaftesbury.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 4 0	
No. 1 Foundry	4 7 6	—
No. 3 Foundry	4 2 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 19 0	3 19 0
No. 1	3 19 6	3 19 6
Cleveland—		
No. 1	3 12 6	3 12 6
Silicious Iron	3 12 6	3 12 6
No. 3 G.M.B.	3 10 0	3 10 0
No. 4 Foundry	3 9 0	3 9 0
No. 4 Forge	3 8 6	3 8 6
Mottled	3 8 0	3 8 0
White	3 8 0	3 8 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 12 6	—
,, ,, Foundry	4 1 6	—
(3) Northampton—		
Foundry No. 3	3 7 6	—
Foundry Forge	3 6 0	—
(3) Derbyshire—		
No. 3 Foundry	3 12 6	—
Forge	3 10 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 12 6	—
No. 4 Forge	—	—
Basic	3 12 6	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 13 6 (a) / 4 16 6 (b) / 5 0 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 15 0	10 10 0
Best	—	—
N.E. COAST—		
Iron Rivets	12 5 0	—
Common Bars	11 5 0	—
Best Bars	12 5 0	—
LANCS.—		
Crown Bars	11 0 0	—
Second Quality Bars	10 0 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	11 10 0	—
Best Bars	12 5 0	—
Hoops	14 0 0	—
MIDLANDS—		
Crown Bars	10 15 0 to 11 0 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	10 5 0	—
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	11 0 0
Ship Plates, ¼in. and up	8 2 6	7 12 6
Sections	7 12 6 to 7 15 0	7 2 6
Steel Sheets, under 3/16in. to ¼in.	10 0 0 to 12 0 0	
Sheets (Gal. Cor. 24 B.G.)	—	£15 0 0 to 16 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 2 6	—
Angles	7 12 6	—
Boiler Plates	12 10 0	—
Joists	7 12 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	
Billets	8 0 0 to 11 10 0	
MANCHESTER—		
Bars (Round)	8 15 0	—
,, (Small Round)	8 2 6	—
Hoops (Baling)	11 0 0	11 0 0
,, (Soft Steel)	10 0 0	10 0 0
Plates	8 7 6	—
,, (Lancs. Boiler)	11 5 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	7 5 0 to 7 10 0	
Hoops	12 0 0	—
Soft Wire Rods	9 5 0	—
MIDLANDS—		
Small Rolled Bars	8 0 0 to 8 10 0	
Billets and Sheet Bars	6 15 0 to 7 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	14 12 6 to 14 15 0	
Angles	7 12 6	—
Joists	7 12 6	—
Toes	8 12 6	—
Bridge and Tank Plates	8 7 6	—
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/3 to 19/6
Block Tin (cash)	291 10 0
,, (three months)	284 12 6
Copper (cash)	54 7 6
,, (three months)	55 0 0
Spanish Lead (cash)	24 6 3
,, (three months)	24 13 9
Spelter (cash)	28 7 6
,, (three months)	28 7 6
MANCHESTER—	
Copper, Best Selected Ingots	59 7 6
,, Electrolytic	60 12 6
,, Strong Sheets	86 0 0
,, Tubes (Basis Price) lb.	0 1 0½
Brass Tubes (Basis Price) lb.	0 0 11½
,, Condenser lb.	0 1 1½
Lead, English	26 15 0
,, Foreign	25 10 0
Spelter	29 2 6
Aluminium (per ton)	£107

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 15 0	7/3
,, ,, 8 p.c. to 10 p.c. ,,	£22 7 6	6/6
,, ,, Specially Refined		
,, ,,Max. 2 p.c. carbon	£36 5 0	11/6
,, ,, ,, 1 p.c. ,,	£42 5 0	13/-
,, ,, ,, 0.70 p.c. carbon	£54 0 0	17/6
,, ,, ,, carbon free	1/5d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£12 10 0 for home, £16 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 5 0 unit	scale 5/- per
,, ,, 75 p.c.	£19 5 0 unit	scale 6/- per
,, Vanadium	14/3 per lb.	
,, Molybdenum	5/- per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Ferro-Cobalt	9/3 per lb.	

FUELS.

SCOTLAND.
(Prices not stable.)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/-.
,, ,, Ell	14/3
,, ,, Splint	15/6 to 16/6
,, ,, Trebles	14/6
,, ,, Doubles	13/- to 13/6
,, ,, Singles	13/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/9
,, ,, Jewel	15/6
,, ,, Trebles	14/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/3 to 13/6
Screened Navigation	18/- to 19/-
Trebles	14/6 to 15/3
Doubles	13/6
Singles	12/9 to 13/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/3
Secondary Steam	12/9
Trebles	14/6
Doubles	13/3 to 13/6
Singles	13/-

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		27/6
Household		42/6 to 58/6
Coke		27/6
NORTHUMBERLAND—		
Best Steams		14/6
Second Steams		13/9 to 14/-
Steam Smalls		10/6
Unscreened		13/- to 13/6
Household		21/- to 27/-
DURHAM—		
Best Gas		16/6 to 17/-
Second		14/3 to 14/9
Household		21/- to 27/-
Foundry Coke		23/6 to 26/6
SHEFFIELD—		
Best Hand-picked Branch	27/6 to 28/6	
Best Selected House Coal	21/- to 22/6	—
Screened House Coal	19/- to 21/-	—
,, ,, Nuts	16/- to 17/6	—
Yorkshire Hards	16/- to 17/-	—
Derbyshire Hards	16/- to 17/-	—
Rough Slacks	10/6 to 11/6	—
Nutty Slacks	8/- to 9/-	—
Smalls	3/- to 5/6	—
Blast-furnace Coke (Inland)	22/- *	—
,, ,, (Export)	f.o.b.	17/6 to 18/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	22/- to 22/6
Second ,, ,,	20/6 to 21/6
Best Dry Large	20/- to 20/6
Ordinary Dry Large	19/- to 19/6
Best Black Vein Large	20/6 to 21/-
Western Valley Large	19/- to 19/6
Best Eastern Valley Large	18/6 to 19/-
Ordinary ,, ,,	18/- to 18/6
Best Steam Smalls	14/- to 14/6
Ordinary Smalls	12/- to 14/-
Washed Nuts	18/- to 21/6
No. 3 Rhondda Large	22/- to 23/-
,, ,, Smalls	16/- to 17/-
No. 2 ,, Large	18/6 to 19/6
,, ,, Through	17/- to 17/6
,, ,, Smalls	13/- to 13/6
Foundry Coke (export)	40/- to 45/-
Furnace Coke (export)	30/- to 32/6
Patent Fuel	25/- to 26/-
Pitwood (ex ship)	30/- to 30/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	41/- to 45/-
Seconds	30/- to 37/-
Red Vein	25/- to 30/-
Machine-made Cobbles	45/- to 50/-
Nuts	45/- to 47/6
Beans	32/6 to 35/-
Peas	20/- to 22/-
Breaker Duff	9/- to 9/3
Rubbly Culm	11/- to 11/9
Steam Coals:	
Large	21/- to 22/-
Seconds	19/- to 21/-
Smalls	11/- to 12/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. * Official quotation for pig iron producers.

French Engineering Notes.

(From our Correspondent in Paris.)

The Coal Situation.

THE prohibition of coal imports, except under licence, has aroused a much greater stir amongst consumers than the Government had probably foreseen, and the protests of importers cannot fail to have some effect by showing that the general interests of the community must not be sacrificed to the interests of a particular class. The Government has restricted the importation of coal on the assumption that the money saved on the purchase of foreign coal is a clear gain to the country, and it is furthermore committed to this policy by the promise it made to recompense miners for their patriotism in augmenting the production of coal and saving the country from disaster during the period of the colliers' strike in Great Britain. It is sought to appease public feeling by declaring that the restriction will only be enforced so long as there is no inflation of French coal prices. On this latter point there can be no illusion whatever, for when the licence system was introduced once before, prices of French coal immediately advanced, and, as a matter of fact, the Government promised coalowners to assist them in obtaining more remunerative prices in return for an advance in wages, by means of which a strike was averted at a vital moment. In the metallurgical trades it is regarded as unfair that so much consideration should be shown to the miners, who are generally better paid than workers in other industries, and they will be the first to suffer from an inevitable advance in the price of coal, which will increase production costs and place French manufacturers in an unfavourable position to do foreign business. Again, the railway companies will have to use French coal exclusively, and pay more for it, and that may mean a further increase in freights, which are already from six to ten times above the pre-war level. The interests of coal importers are considerable, and ports like Rouen depend almost entirely for their prosperity upon the coal trade. Thus, for the sake of one class of owners and workers, and in the mistaken belief that money paid for foreign products is necessarily lost to the country, the whole community will suffer more or less from dearer fuel. The idea is gaining ground that the policy of prohibiting coal imports will be fatal to the country's industrial prosperity, and it may be assumed that, if the licence system is maintained, the Government will eventually find it necessary to grant permits with increasing liberality.

Tariffs and Coal.

The delay in resuming the debate upon the Tariff Bill appears to be due to the necessity of Government considering something like eighty amendments from members of the Chamber, and in view of the stand taken by the Chamber of Deputies against an exaggerated inflation of import duties, it is curious to learn that the majority of the amendments aim at increasing still further the already prohibitive duties proposed by the Customs Commission. The situation is complicated by the fact that Germany is taking a very decided stand over the question of fiscal tariffs. The German representatives have returned to Paris with a view of resuming negotiations for a commercial treaty, and it is probable that the temporary arrangements between the two countries, which expires at the end of the month, will be renewed for another period to avoid any undue haste in pushing through the Tariff Bill. The prohibition of coal imports has raised a further difficulty, as the Germans appear little disposed to have their hands forced by that or other means, and it is becoming more and more evident that the French Government will experience great trouble in negotiating with a tariff which aims at protecting all industries in the most effective manner. The main reason why the French are so anxious to treat with Germany is to provide a market for the surplus production of wines and to allow of Alsace and Lorraine exporting metallurgical and other products to that country. These considerations outweigh everything else at the present moment, and the Germans are not likely to give way unless they receive compensating advantages and almost certainly a suppression of the prohibition of coal imports. The question for the French to consider is whether the interests of the great agricultural industry are to be sacrificed for the sake of protecting other industries of less importance.

Industrial Agreements.

The negotiations for the formation of cartels in various branches of the metallurgical industries are encountering so many obstacles that there appears little prospect of carrying out fully the scheme of allotting to each country a quota of production according to requirements. The Steel Cartel has passed through a rather trying period, and, although its existence is deemed necessary to prevent a collapse of the steel industry, there is, nevertheless, a good deal of dissatisfaction alike as regards the failure of the Cartel to do what was expected of it, and the claims that continue to be made by some countries for an increased participation. Still, it is recognised that if the Cartel collapsed the situation would be far worse than it is now. The French steel makers are all in favour of a continuance of the agreement. The efforts to create an international union of wire rod makers have so far failed, although the agreement for fixing prices remains in force. Two other agreements have been dissolved.

Railway Accident.

An accident very similar to that which occurred a year ago resulted in the loss of nine lives and a large number of injured on the Paris, Lyons and Mediterranean Railway just outside the station of Bessay, between Moulins and St. Germain-les-Fossés. Early in the morning several trucks of an up goods train became derailed and fell on to the down line just as the Paris-Nimes express was approaching at a speed of 59 miles an hour. The express crashed into the trucks, the locomotive overturning, and the five first coaches telescoping into each other.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

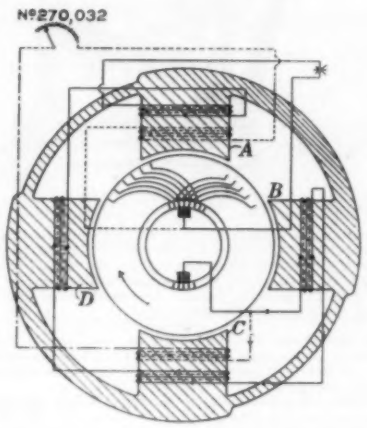
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

270,032. February 19th, 1926.—IMPROVEMENTS IN GENERATORS FOR ELECTRIC ARC WELDING, Malcolm Miller Irvine, of the Double Arc Welders, Ltd., 26, India-street, Charing Cross, Glasgow.

The arc-welding generator described in this specification has its poles split into parts, A and B of north polarity and C and D of south polarity. The armature winding has a coil span of approximately half the normal pole pitch. The brushes are arranged so as to collect current generated from the part A C only. Shunt and series windings are provided and connected as shown.



The arrangement of the poles and windings gives a drooping characteristic effect, and the active belt of conductors in conjunction with the poles B D and the series windings on these poles provides a choking coil effect which is of assistance in preventing spluttering of the arc. To assist in producing the drooping characteristic effect, the air gaps under the main part poles A C are made smaller than those under the so-called auxiliary poles B D, and the total ampère turns on the auxiliary pole axis, including those due to armature reaction, are greater than the total number of ampère turns on the main pole axis. The principle of the machine is fully described.—*May 5th*, 1927.

SWITCHGEAR.

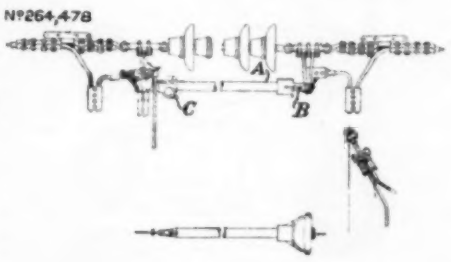
268,305. February 17th, 1927.—IMPROVEMENTS IN OIL SWITCHES, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

Experiments with oil switches have shown that for preventing the occurrence of high pressures in the containers, the air space in the switch must bear a definite proportion to the size of the gas bubble produced when the greatest load is interrupted. According to this invention, the air volume above the oil surface in the switch container—or total volume in all the containers, where there are two or three switch tanks—amounts for each 100,000 maximum three-phase kVA rupturing capacity to at least $50 + {}^1/_8$ E litres, or in the case of single-phase current to two-thirds of the above amount, E being the line rated voltage of the switch in kV. In the case of the oil switches for single-phase networks, the minimum air volume for each 100,000 maximum single-phase kVA rupturing capacity will amount to two-thirds of the above, i.e.—$L = 33 + {}^1/_8$ E litre. Experiments have proved the correctness of these conclusions, and have shown that, when the air space of this size is provided, no inadmissible pressures are produced in the oil switch.—*May 5th*, 1927.

TRANSMISSION OF POWER.

264,478. December 23rd, 1926.—IMPROVEMENTS IN SWITCH DEVICES FOR ELECTRIC TRANSMISSION LINES, *Metropolitan-Vickers Electrical Company, Ltd., of 4, Central Buildings, Westminster.*

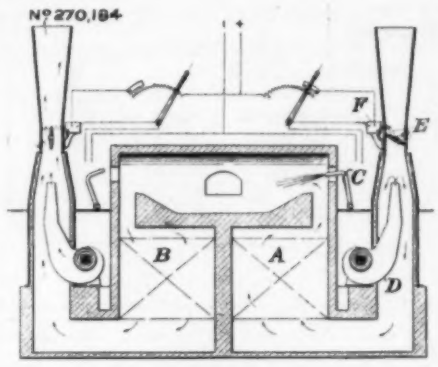
For electrically connecting and disconnecting two sections of a transmission line mechanically connected by a string of insulators, a switch arm A is provided, and when it is closed it bridges the insulators. At one end the arm is hinged at B, whilst at the other end it engages with spring jaws, an eye being provided at C for engagement with a hook stick. At each end of the string of insulators there are supports capable of independent angular adjustment about the axis of the string of insulators.—*May 5th*, 1927.



FURNACES.

270,184. December 7th, 1926.—REGENERATIVE FURNACES, *A. E. White, 88, Chancery-lane, London, W.C. 2.*

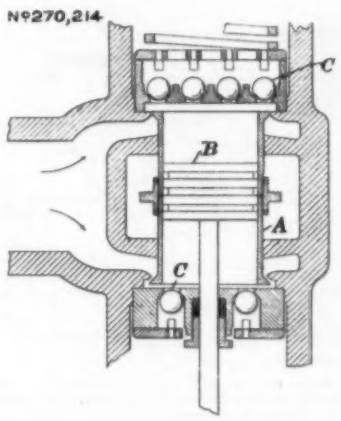
This invention is concerned with the reversal of the flow of gases through regenerative reverberatory furnaces, and apparently suggests the adoption of oil fuel. The two regenerators are indicated at A and B, and, as shown in the illustration, the flow is proceeding from the right to the left. In these circumstances, the burner C is in operation, the blower D is running at a comparatively slow speed merely to feed air into the furnace, the damper E is closed by the electro-magnetic device F, and the other fan is running at full speed to induce a draught towards the left. It will be observed that the whole of the control apparatus is duplicated on either side of the furnace, and that, by reversing these controls, reversal of the flow is effected.—*May 6th*, 1927.



PUMPING AND BLOWING MACHINERY.

270,214. January 23rd, 1926.—VALVE MECHANISM OF AIR COMPRESSORS, A. G. Enock, Dutch House, Raglan-gardens, Wembley Park, Middlesex.

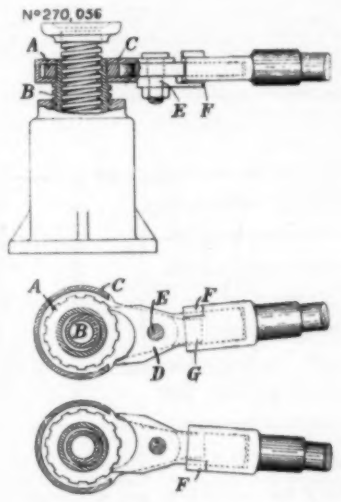
The object of this invention is to provide a very free passage of air, or gas, into the compressing cylinder during the suction stroke. For this purpose the cylinder liner A is made free to slide within the main casting and reciprocates, as far as is possible, with the piston B. The ends of the liner, in conjunction with the end covers, form inlet valves of large area, while the discharge valves C C may be of any orthodox design.—*April 25th*, 1927.



MACHINE TOOLS AND SHOP APPLIANCES.

270,056. March 22nd, 1926.—SCREW JACKS, Tangyes Ltd., Cornwall Works, Birmingham, W. Chapman, 207, Northfield-road, King's Norton, Birmingham, and D. M. Hodgkinson, 69A, Rookery-road, Handsworth, Birmingham.

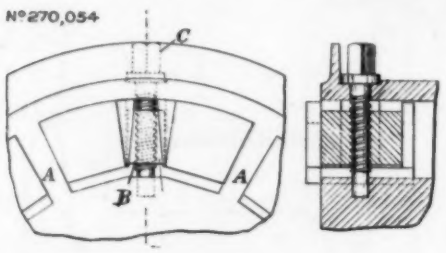
In this jack a ratchet wheel A is fixed to the screw B and is embraced by a housing C. Within this housing there is a double-ended pawl D, pivoted at E. The pawl is extended to accommodate a socket on the end of the hand lever, and this socket has a lug F, which engages with an extension G of the housing



C. The operation of the jack is obvious, but it should be pointed out that by turning the hand lever upside down—see the lower view—the jack is reversed.—*May 5th*, 1927.

270,054. March 20th, 1926.—ABRADING WHEELS, Tasker's Engineering Company, Ltd., and T. Hudson, 59, Blonk-street, Sheffield.

This invention is concerned with the fixing of segment-shaped abrasive blocks in the wheels of grinding machines. The blocks are mounted in pairs, in pockets in the wheel bounded by the radial fins A A. They are clamped in place by the compound

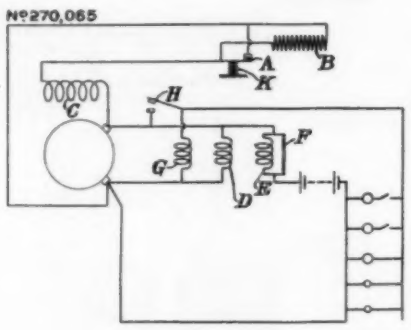


wedge B, the centre part of which may be drawn up tight by the screw C. It is explained that the central part of the wedge will tend to move outwards under the influence of centrifugal force, and thus augment the clamping effect, but also that a tap with a hammer on the end of the screw will release the clamping pressure, so that the abrasive blocks may be easily released.—*May 5th*, 1927.

MOTOR CARS AND ROAD TRAFFIC.

270,065. March 30th, 1926.—IMPROVEMENTS IN AND RELATING TO REGULATORS FOR DYNAMO-ELECTRIC MACHINES, William Henry Glaser and C. A. Vandervell and Co., Ltd., both of Warple-way, Acton Vale, Acton, London, W. 3.

The regulator described in this specification, apparently intended mainly for regulating the voltage of car dynamos, comprises interrupting contacts which vary the field excitation of the dynamo. The interrupting contacts A are shunted across a resistance B in series with the shunt excitation coil C of the dynamo, and they are moved relative to one another by means of a voltage coil D and a series coil E shunted by a resistance F. The magnetic core of the regulator on which the coils D and E are mounted is also provided with an additional coil G, and the

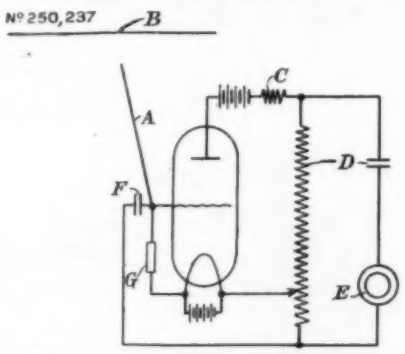


switch H is arranged so that none of the lamps on the vehicle can be put into operation unless this is closed, and the additional voltage coil connected in circuit. The series coil E and the resistance F are not in the lamp circuit. The spring K is adjusted so as to ensure that a sufficiently high voltage is obtained for charging the battery to the maximum value necessary for gassing. None of the lamps can be switched on without the master switch first being closed, and therefore without the switch connected in series with the additional voltage coil H being closed. The additional voltage coil ensures that the interrupting contacts A are separated to such an extent against the action of the regulator spring K that the voltage generated at the terminals of the dynamo shall not reach a value that would endanger the life of the lamps.—*May 5th*, 1927.

MISCELLANEOUS.

250,237. March 30th, 1926.—AN ELECTRICAL TENSION INDICATOR, Aktiengesellschaft Mix und Genest, Telephon-und Telegraphen Werke, of 5, Genestrasse, Berlin-Schöneberg, Germany.

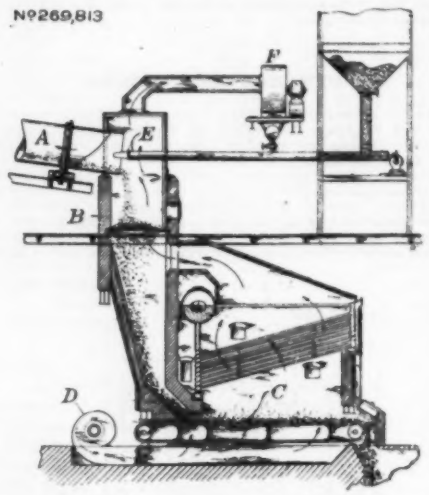
The device described in this specification is for showing whether conductors are energised. The grid of a valve is provided with a conductor A which projects into the field produced by a conductor B. In the anode circuit of the valve there is an



electro-magnetic relay C and an oscillatory circuit D composed of an inductance and condenser. There is also a telephone E. A condenser F is connected in the grid circuit as shown, and a high resistance is provided at G. Normally the telephone emits a continuous sound, but if the wire A is brought into the field of the conductor B which is under tension the grid of the valve is negatively charged and the telephone receiver ceases to operate. At the same time the interruption of anode current causes the relay C to release its armature and to insert any suitable device in the circuit for the purpose of indicating that the conductor B is alive. The device may be used in various ways. It is considered, for example, that it might be employed to attract the attention of an engine driver at any part of the track, and for the purpose the conductor B, which in this case would be energised at will, would be laid at the side of the track.—*April 28th*, 1927.

269,813. December 11th, 1926.—UTILISING THE WASTE HEAT OF KILNS, Babcock and Wilcox, Ltd., Farringdon-street, London, E.C. 4.

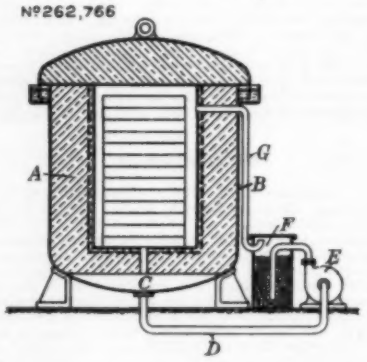
The incandescent clinker from the rotary cement kiln A falls on to a grate B, through this grate, down a sloping shoot and on to the travelling grate C beneath a boiler. Air is blown



through the grate by the fan D, is heated as it passes through the hot clinker, and in turn heats the boiler. This air is re-heated as it flows up the shoot and supports the combustion in the kiln of powdered coal supplied by the burner E. F is a fan for mixing hot air with the powdered fuel. The products of combustion escape up the kiln.—*April 28th*, 1927.

262,766. December 3rd, 1926.—MEANS FOR DRYING ELECTRIC BRIGHT ANNEALING FURNACES, Siemens-Schuckertwerke Gesellschaft mit beschrankter Haftung, of Berlin-Siemensstadt, Germany.

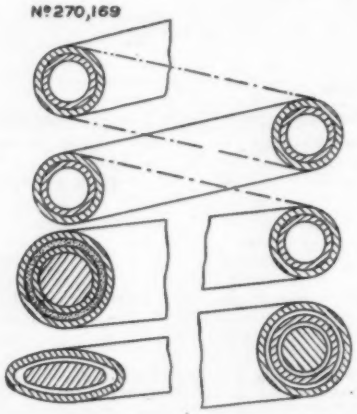
In electric bright annealing furnaces which operate with hydrogen gas as the protecting gas, steam may be generated during working in the interior of the furnace, and will condense at the coolest part of the furnace and render bright annealing impossible. According to this invention, the protecting gas and the vapours are drawn off from the furnace by means of a



rotary pump, and are forced through a receptacle filled with a substance suitable for retaining the vapours. The bright annealing furnace A, with the jacket B, is provided with a packing or sealing duct running round it, into which the lower edge of the lid penetrates. To the deepest point of the sump C a pipe D is connected and leads to the rotary pump E, which conducts the gases and vapours through the receptacle F filled with a substance suitable for retaining the vapours. The dried protecting gas is again passed to the furnace through the pipe G.—*May 5th*, 1927.

270,169. November 19th, 1926.—COILED SPRINGS, E. W. Timmis, 2, Wood-street, Westminster, S.W. 1.

The inventor proposes to make helical springs by coiling



telescoped tubes, with the object of providing a damping effect by the mutual friction of the two, or more, thicknesses of metal.—*May 5th*, 1927.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

DIESEL ENGINE USERS' ASSOCIATION.—Caxton House, Westminster, S.W. 1. "Consumers' Oil Tests," by Mr. A. F. Evans. 3 p.m.

HEAT ENGINE TRIALS COMMITTEE.—At the Institution of Civil Engineers, Great George-street, S.W. 1. Report of the Special Committee on Tabulating the Results of Heat Engine Trials will be submitted for discussion. 6 p.m.

ROYAL INSTITUTION.—21, Albemarle-street, W. 1. Discourse, "The Excavations at Ur," by Mr. C. Leonard Woolley. 9 p.m.

THE PHYSICAL SOCIETY.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. The following papers will be read:—"The Latent Heat of Evaporation of Sulphur," by J. H. Awbery, B.A., B.Sc.; "The Refraction and Dispersion of Carbon Tetrachloride," by H. Lowery, M.Sc., F. Inst. P.; "Regularities in the Spectrum of Ionised Neon," by P. K. Kichlu, M.Sc.; A demonstration of the Schönherr-Hessburgh nitrogen fixation are will be given by Captain G. I. Finch. 5 p.m. Editing Committee meeting at 3.45 p.m. Council meeting at 4 p.m.

SATURDAY, JUNE 11TH.

THE INSTITUTION OF CIVIL ENGINEERS.—Birmingham and District Association. Visit to London, Midland and Scottish Railway Works at Barnt Green. Members will assemble at Barnt Green Station at 10.49 a.m.

TUESDAY, JUNE 14TH.

UNIVERSITY COLLEGE, GOWER-STREET, LONDON, W.C. 1.—In connection with the centenary celebrations of the College, Professor J. A. Fleming, F.R.S., will deliver an address, entitled "A Hundred Years of Electrical Engineering." 8.30 p.m.

WEDNESDAY, JUNE 15TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—The Pavilion, Torquay. Fifty-fourth annual general meeting 10 a.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington. Papers: (1) "Report on the Phenological Observations in the British Isles, December, 1925, to November, 1926," by Messrs. J. Edmund Clark, I. D. Margary and R. Marshall; (2) "Past Climates," by Dr. G. C. Simpson, F.R.S.; and (3) (if time permits) "The Variation of Eddy Viscosity with Wind Velocity and Season: A Study Based on Pilot Balloon Observations at Melbourne," by Mr. H. M. Treloar, B.Sc., communicated by Dr. E. Kidson. 5 p.m.

SOCIETY OF GLASS TECHNOLOGY.—The Applied Science Department, The University, St. George's-square, Sheffield. The hundredth general meeting. Papers: (1) "Gaseous Fuels for Furnace Heating," by Mr. R. Wigginton, B.Sc. (Department of Fuel Technology, The University, Sheffield); and (2) "The Thermal Expansion of Some Boric Oxide Glasses and Some Remarks on the Influence of the Inhomogeneity of the Glass," by Professor W. E. S. Turner and Mr. Francis Winks, M.Sc. Tech. 2.30 p.m. To be preceded at 1 p.m. by a luncheon at the King's Head Hotel, Sheffield.

MONDAY TO WEDNESDAY, JUNE 20TH TO 22ND.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Summer meetings at Bournemouth.

TUESDAY, JUNE 28TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Visit to the Kent Cement Works at Greenhithe by steamer, which will start from Westminster Bridge Pier at 10 a.m.

SATURDAY, JULY 2ND.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Visit to the Castleton Works of Messrs. Tweedale and Smalley.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—The Town Hall, St. Annes-on-Sea. North-Western District meeting. 10.30 a.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

SIR RICHARD TETLEY GLAZEBROOK, K.C.B., F.R.S., has been appointed, by Order of Council dated May 26th, 1927, to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

FILMA OIL BURNERS, Ltd., asks us to announce that it has moved its offices from 4, Broad Street-place, London, E.C. 2, to 68, Victoria-street, Westminster, S.W. 1, and requests that all communications should be sent to the latter address.

CONTRACTS.

MERRYWEATHER AND SON, Ltd., provided the equipment for use in the event of fire for the new Grand Stand at the Epsom racecourse.

BEDFORD ENGINEERING COMPANY, of Bedford, has received from the Port of London Authority an order for six electric cranes for the Royal Victoria Docks.

THE NETHERLAND SHIPBUILDING COMPANY (Nederlandsche Scheepsbouw-Maatschappy), of Amsterdam, has received from the Stoomvaart-Maatschappij "Nederland" an order for a motor cargo ship, of 10,500 tons deadweight; dimensions, 490ft. by 61ft. by 36ft. 9in. The propelling machinery to be supplied by the Gebr. Sulzer A.G. to Winterthur; and an order from Norwegian owners for a motor tank ship of 13,160 tons deadweight, dimensions 473ft. 6in. by 64ft. 3in. by 36ft. 6in., the twin-screw Diesel motor installation of 4200 I.H.P. being supplied by Werkspoor.